[[1]](#footnote-2)

Preparation of Technology Letters for the IEEE Open Journal of Engineering in Medicine and Biology (OJEMB)

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*Abstract*— *Goal:* WebBioBank (WBB) is a web-based platform to collect and share anonymous patients’ biosignals with Parkinson’s disease (PD) undergoing clinical treatments such as deep brain stimulation. The goal of this study was to characteristically categorize WBB biosignals utilizing computational algorithms. *Methods:* We summarized the recordings information in a metadata file and developed Matlab scripts to format and classify the biosignals. *Results:* 561 signals from 57 PD patients were classified based on personal information and clinical status such as on/off medication and stimulation. The old .txt files of signals were modified and their IEEE JSON format were created. Additionally, signal gains were estimated if missing. *Conclusions:* The algorithms developed in this study can be used to organize any kind of big biosignal bank, where their manual edit would be a cumbersome task. The future plan is to embed online signal processing tools on WBB for scientific analysis and clinical investigations.

*Index Terms*—Enter up to 5 keywords in alphabetical order, separated by commas.

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# INTRODUCTION

F

or more than 15 years of advanced research, WebBioBank (WBB) collects biosignals coming from patients recorded in different condition and from different brain areas developed by Newronika … It has been established since X and has been used in X institutions/research centres.

We present a background of Webbiobank (WBB) and in the next session we address the new features and updates.

>> Data base and server structure of WBB. The WBB system architecture is explained in detail in [Rossi JBI 2014]

Languages and structure:

data banks server and client sides: For each patient there are questioners

>>> signals of 10 minutes, beta is computed every minute. Now on the app and WBB the signal is shown plus the beta power in a desired time period.

These are done for both left and right electrodes in each signal.

>> Implementation of signal processing tools such as spectrograms, filtering in different rhythms, calculation of phase-amplitude coupling etc.

**Updates on WBB, the modifications and new stuff**

The view of the signals and their features such as … are available to the authorized researchers and clinicians.

>> Modifications done: modifying the tabs and appearance, adding users and patients.

We went over modifying the data tables and case report form (CRF).

It is going to be implemented on the WBB patient's data (info). Also amount of medication etc. (Mention what is done new…)

>> We went over the device tab as well. This shows the device names and their properties. In the device list we have

the list of those devices that are paired to the patients, and which patients they are paired with.

Manufacturer medtronic and activaPS (or TM SC, not sure, check later).

>> In the patients list and each patient information, there are three tabs, questionaire, signals and devices.

Signals are the signals recorded from a specific area of the patient and devices are the attached devices to the patient.

Recommendations and alternative approaches, lessons learned, comparison with current systems

The matlab codes are applied on part of the WebBioBank (WBB) developed by Newronika S.p.A. This data set contains local field potential (LFP), Electroencephalographical (EEG), Electromyographical (EMG) and other types of recordings from patients with Parkinson's disease (PD) gathered over years from both male and female genders and different range of ages. The pateints were undergone deep brain stimulation (DBS) implantation surgery, by which the LFPs where recorded in different settings such as off/on DBS, off/on medication, rest/move etc.

# Materials and Methods

This repository contains Matlab script codes to clean up and categorize the data on Newronika WebBioBank data base. The codes can be used to clean and group any kind of biological and brain recording data bank, where big amount of data is stored and their manual selection and edit would be cumbersome.

## Metadata file

A unique pateint ID (PID) is given to each patient name. Each signal is labeled by a signal ID (SID) that is unique. At the end, each old file is named by combining PID and SID so that the new file name is in the format of PIDxxxx\_SIDxxxxx where x is an integer.spacing to squeeze more text into a limited number of pages.Use italics for emphasis; do not underline.

The information of each recording and subject is gathered in a metadata file as a sheet, such as in Microsoft Office Excel format. Each row presents one of our signals with the corresponding filename PIDxxxx\_SIDxxxxx and the columns gather the overall information of the subject and the recorded signal.

The columns in the metadata file are explained in Table I.

## Converting old files to the new ones (FileAdopter.m)

The objective of this data management is to read the old files in the data base, which contain different format of saving the signals and convert them to a one-column .txt file:

"Fs= " x

V(1)

V(2)

V(3)

V(4)

.

.

.

V(end)

where x is the sampling frequency of the signal in Hz and V is the value of the signal at a given time sample.

All signal files are in .txt format, either the old or the new versions. The files that contain different signals from different subjects in the old format could have different rows and columns such as:

"Time" "31 Keyboard" "2 untitled" "1 untitled"

0.0000 0.000000

0.0004 0.000000 0.62805 0.88745

0.0008 0.000000 1.20544 0.90698

0.0012 0.000000 0.89966 0.61035

The first column contains the time in most of the cases and the other rwos contain the signals. The signals could be different types of the same subject, such as LFP and EMG or different channels of LFP recording etc.

TABLE I

Metadata file column description

|  |  |
| --- | --- |
| Column | Description |
| FileName | The new file name in the format PIDxxxx\_SIDxxxxx |
| PatientID | The unique ID for each patient |
| SignalID | The unique ID of each signal |
| SourceFile | The name of the old file |
| FileLocation | The location of the old file |
| SubjectType | Type of the subject in the study  e.g. patient or animal |
| SubjectName | Name of the subject |
| SubjectGender | The gender of the subject, M/F |
| SubjectDoB | Subject date of birth |
| SubjectCondition | The subject's pathology, e.g. PD |
| SignalType | The type of signal e.g. LFP, EEG |
| SignalContent | Voltage trace or spectral content |
| BodySite | The recording site on the subject body |
| Channel | The recording channels |
| Medication | Medication state ON/Off |
| Stimulation | Stimulation state ON/Off |
| SignalUnit | Unit of the recorded signal |
| Number\_Column\_SourceFile | This column is used for the data conversion code and mentions the column in the old file where the new file is constructed on |
| SignalFs | Signal sampling frequency (Hz) |
| SignalGain | Gain of the signal |
| EstimatedGain | The estimated gain in case the gain was not reported in the old file and corresponding data base |
| SignalBandWitdth | Bandwidth of the recorded signal |
| Notch | If Notch filter was used on the original signal or not |
| RecordingData | Date of the signal recording |
| RecordingHour | Hour of the signal recording |
| SignalDuration\_s | Duration of the signal (s) |
| Comments | Any comments |
| LinkPaper | Mentions the paper where the data has been used/analyzed |
| BackupFolder | The folder where the backup of the old signal exists |
| StimFreq | Stimulation frequency (Hz) |
| StimAmp | Stimulation amplitude (mA) |
| StimPulseDuration\_us | Stimulation pulse duration (µs) |

Another format could be like this:

"INFORMATION"

"Prova2.smr"

""

""

"SUMMARY"

"1" "Waveform" "untitled" " volt" 256 255.754476 1 0

"31" "Marker" "Keyboard"

"CHANNEL" "1"

"Waveform"

"No comment"

"untitled"

" volt" 256

"START" 0.00000 0.00391

-0.00565

-0.01022

-0.01175

-0.01297

and many other formats. So far we have identified 13 types of recording formats. The matlab script FileAdaptor.m reads the metadata file and converts the old format files for these 13 cases to the new file format such as below:

"Fs= " 512

1.928736

-0.182643

0.024379

1.283741

.

.

.

-0.374178

and names it by the unique PIDxxxx\_SIDxxxxx ID so that all the information about the signal and subject can be retrieved from the metadata file. The new file will be saved in the desired destination. The frist row indicates that the sampling frequency (Fs) is 512 Hz, and the rest of the rows contain the signal values at each time sample.

## Estimate the signals gain (GainEstimator.m)

In some cases the gain of the signal i.e. the value that the recording device has used to record the signal was not known. However, we know that for example deviding the value of the signal by gain for LFPs should be in microvolts order of magnitude. Also in some cases it can be guessed by other existing values of the same subject.

GainEstimator.m reads the metadata file and wherever that the gain was not given, tries to estimate a gain based on the SignalType and writes it to the metadata sheet and save.

## Create .json from the new files (JsonAdoptor.m)

For web applications such as WBB, it is extremely handy to merge every signal with the corresponding information from the metadata file in one single filein .json format.

The code JsonAdoptor.m is a script that megres these information and save each new signal in .json format in aprallel with .txt file that already exists. The code uses the function saveAsJSON.m bBased on the work of Lior Kirsch at: https://uk.mathworks.com/matlabcentral/fileexchange/50965-structure-to-json. This code helps researchers and web developers along with bioengineers to save any signal in .txt format along with its information as a .json file using matlab.

## Clean up the data set (FileCleaner.m)

There where some files in the data base with no given Fs and since this property is essential for any kind of data analysis, one might want to keep only the signals with given Fs. The other essnetial property of the signal that is required for data analysis is the SignalType, which indicates if it is LFP, EEG or any other type of biosignals.

In this regard, FileCleaner.m reads the metadata file, identifies those files that have at least both Fs and SignalType reported and save them in a new folder called Clean. The corresponding .json files will be saved in the new folder as well.

Data Identification & Classification; Signal\_identifier\_classifier.m

We have categorized the signals on WBB based on two distinct classes.

Class-1 collects signals to different "Types":

LFP-EEG-EMG (SignalType)

|

----------------------------(BodySite)

| |

STN GPi

|

---------------------------- (SubjectGender-Medicatioin-SubjectDoB-Stimulation)

| | | |

Gender Med Age DBS

(M,F) (on/off) | (on/off)

|

---------------------------------------------------(age range)

(bleow30,30-40,40-50,50-60,60-70,70-80,80-90,above90)

The hierarchy of class-1 follows:

SignalType-> BodySite-> SubjectGender-> M or F

SignalType-> BodySite-> SubjectDoB-> age range

SignalType-> BodySite-> Medication-> On or Off

SignalType-> BodySite-> Stimulation-> On or Off

Part 1 of the code Signal\_identifier\_classifier.m constructs folders based on class-1 algorithm, copies the files from the parent folder and pastes to the child folder.

Class-2 collects signals to different "Patients":

name1-name2-...\_nameN (SubjectName)

| | |

| the same as name1

|

----------- (SignalType)

LFP-EEG-EMG

|

---------------------------- (BodySite)

| |

STN GPi

|

-------------------- (Channel-Medication-Stimulation)

| | |

Side Med DBS

(L,R) (on/off) (on/off)

The hierarchy of class-2 follows:

SubjectName-> SignalType-> BodySite-> Channel-> Right or Left

SubjectName-> SignalType-> BodySite-> Medication-> On or Off

SubjectName-> SignalType-> BodySite-> Stimulation-> On or Off

Part 2 of the code Signal\_identifier\_classifier.m constructs folders based on class-2 algorithm, copies the files from the parent folder and pastes to the child folder.

The code can be edited easily based on one's need and is written such that any other classification of interest could be added.

# Results

561 signals from 57 PD patients were classified based on personal information and clinical status such as on/off medication and stimulation. This contains around 30 hours of recording from different patients’ biosignals including LFP, EEG and EMG. The old .txt files of signals were modified and their IEEE JSON format were created. Additionally, signal gains were estimated if missing.

## Equations

Number equations consecutively with equation numbers in parentheses flush with the right margin, as in (1). First use the equation editor to create the equation. Then select the “Equation” markup style. Press the tab key and write the equation number in parentheses. To make your equations more compact, you may use the solidus ( / ), the exp function, or appropriate exponents. Use parentheses to avoid ambiguities in denominators. Punctuate equations when they are part of a sentence, as in

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Fig. 1. Magnetization as a function of applied field. Note that “Fig.” is abbreviated. There is a period after the figure number, followed by two spaces. It is good practice to explain the significance of the figure in the caption.

# Discussion

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# Conclusion

## A conclusion section is required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the major findings and significance of the work or suggest applications and extensions.

Supplementary Materials

All the Matlab scripts developed for this study can be found

at: <https://github.com/aafarokh/WBB_NWK>.

Acknowledgment

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References

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1. G. O. Young, “Synthetic structure of industrial plastics,” in *Plastics,* 2nd ed., vol. 3, J. Peters, Ed. New York: McGraw-Hill, 1964, pp. 15–64.
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1. J. U. Duncombe, “Infrared navigation—Part I: An assessment   
   of feasibility,” *IEEE Trans. Electron Devices*, vol. ED-11, no. 1, pp. 34–39, Jan. 1959.
2. E. P. Wigner, “Theory of traveling-wave optical laser,” *Phys. Rev*.,   
   vol. 134, pp. A635–A646, Dec. 1965.
3. E. H. Miller et al., “A note on reflector arrays,” *IEEE Trans. Antennas Propagat*., to be published.

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