Terzo Convegno Nazionale CINI sull'Intelligenza Artificiale

Artificial Intelligence Based Web Platform for Home Screening in Digital Neurology

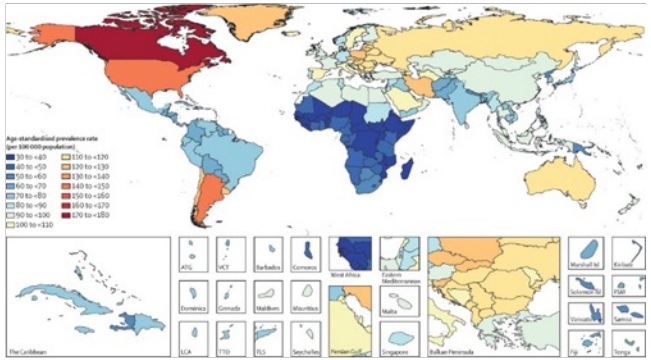
Laganaro F., Calabrese M., Mancini A., Angelucci M., **Pallotti. A**.

30 Maggio 2023
Pisa, Italia
Auditorium Area della Ricerca CNR

Parkinson

seconda malattia neurodegenerativa al mondo

Principali sintomi motori :
- Tremori a riposo
- Rigidità
- Bradicinesia
- Instabilità posturale



Difficoltà di controllo movimenti fini

Modificazioni della scrittura e del disegno

Compromissione scrittura e dell'apparato vocale = elementi decisivi per diagnosi precoce

Esami Strumentali:

DATSCAN e Risonanza Magnetica

Letteratura di riferimento

Scrittura

Classification-Based Screening of Parkinson's Disease Patients through Graph and Handwriting Signals

Fratello, M., Cordella, F., Albani, G., Veneziano, G., Marano, G., Paffi, A., & Pallotti, A. (2021)

- 22 soggetti sani 9 con PD
- 35 soggetti sani e 36 con PD, database Ceco PaHaw

1. Spirale archimedea con guida
2. le le le le le le
3. «I fiori sono sul prato»
4. «Nel cielo ci sono le stelle»
5. 10 cerchi concentrici
6. 7 righe di testo libero

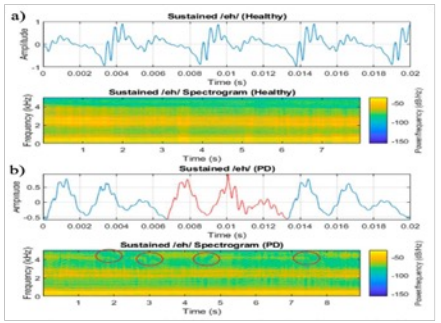
Voce

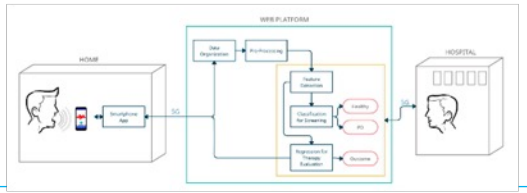
Classification-Based Screening of Parkinson's Disease Patients through voice signal In IEEE International Symposium on Medical Measurements and Applications (MeMeA)(pp.1-6).IEEE

Cordella, F., Paffi, A., & Pallotti, A. (2021)

- 33 pz con PD e 18 sani
- 4 suoni diversi

1. ah
2. eh
3. Iuh
4. iamh





Materiali e Metodi

Graph and handwriting signal based machine learning models development in Parkinson's screening and telemonitoring
Mancini. A., Calabrese R., Angelucci M., Albani G., Veneziano G., Mazza M., Marano G., Paffi A., Pallotti A. (under review)

58 pazienti database Italiano – Casa di Cura Le Terrazze e Ospedale Universitario Gemelli Roma
16 parkinsoniani, 42 di controllo

1- Spirale archimedea con guida

2- le le le le le le

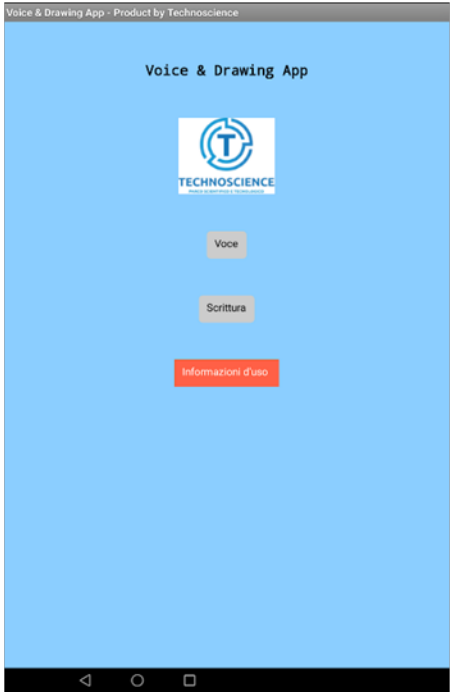
3- «I fiori sono sul prato»

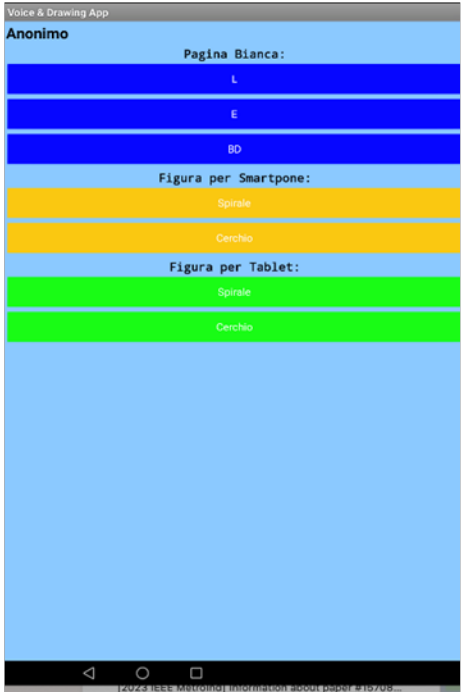
4- «Nel cielo ci sono le stelle»

5- 10 cerchi concentrici

Materiali e Metodi

Voice & Drawing App



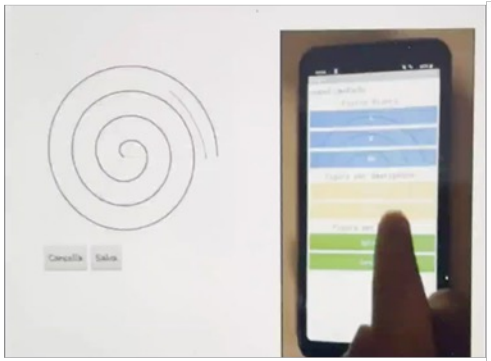


Materiali e metodi

2 soggetti (1 sano, 1 soggetto con PD)

Task Scrittura

1. L
2. E
3. BD
4. Spirale archimedea con guida
5. Cerchio dentro cerchio



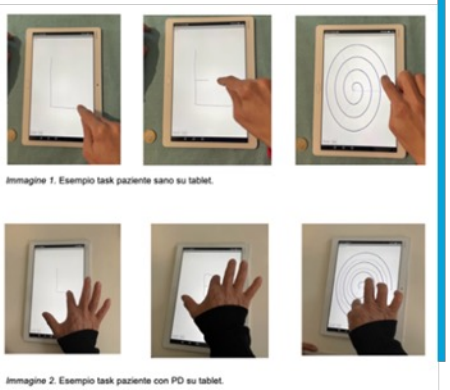
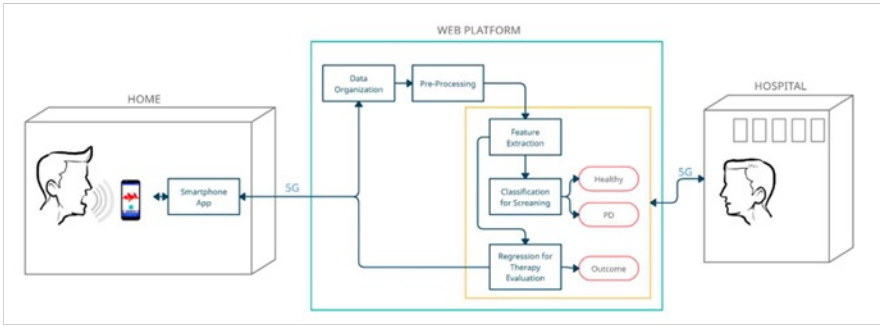


Immagine 1. Esempio task paziente sano su tablet.

Immagine 2. Esempio task paziente con PD su tablet.

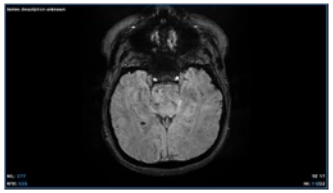
Task Vocale

1. a
2. e
3. iam
4. iu

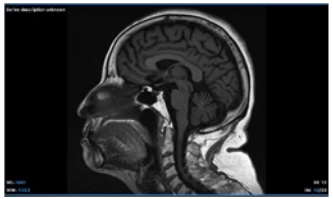


Materiali e metodi

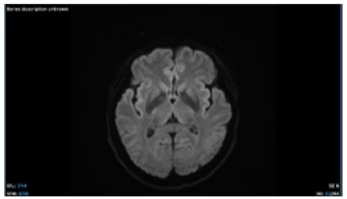
Immagini di Risonanza Magnetica formato Dicom



Sequenza SWI

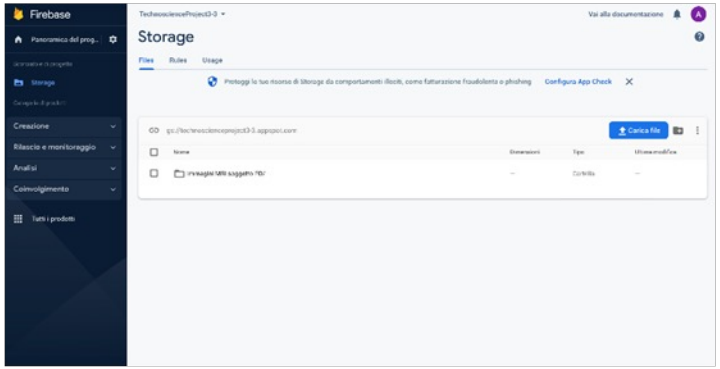


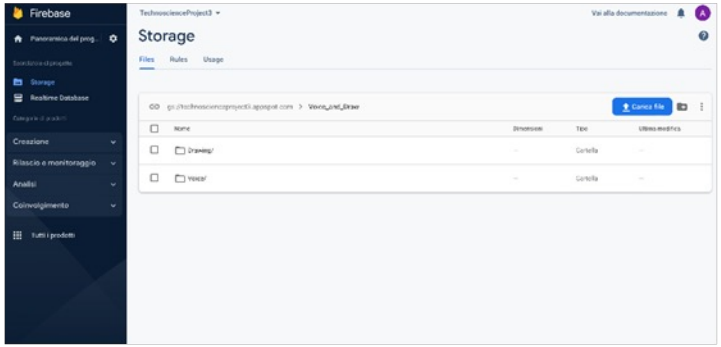
Sequenza T1



Sequenza FLAIR

Piattaforma Firebase con dati voce,scrittura e immagini RM





Risultati

Classification-Based Screening of Parkinson's Disease Patients through Graph and Handwriting Signals
Fratello, M., Cordella, F., Albani, G., Veneziano, G., Marano, G., Paffi, A., & Pallotti, A. (2021)

	Spiral	le	Spiral and le
Model	Linear SVM	Linear SVM	Medium KNN
Accuracy	71.6%	75.5%	77.5%
Specificity	79%	73.7%	77.1%
Sensitivity	62.2%	77.8%	77.8%
F1 Score	65.9%	73.7%	75.3%
Precision	70%	70%	72.9%

	C'	PD'
C	45	12
PD	17	28

	C'	PD'
C	42	15
PD	10	35

	C'	PD'
C	44	13
PD	10	35

Classification-Based Screening of Parkinson's Disease Patients through voice signal
In IEEE International Symposium on Medical Measurements and Applications (MeMeA) (pp. 1-6). IEEE
Cordella, F., Paffi, A., & Pallotti, A. (2021)

Classifier	Type	Accuracy (%)	TPR (%)	TNR (%)	F1 SCORE	AUC
RSL	KNN	**97.3 ± 0.6**	99.0 ± 0.6	93.8 ± 1.6	0.97 ± 0.006	0.97 ± 0.007
IBk	KNN	95.4 ± 0.6	98.2 ± 0.5	89.3 ± 1.7	0.94 ± 0.005	0.94 ± 0.009
MLP	ANN	87.6 ± 0.8	91.1 ± 1.1	74.5 ± 2.9	0.84 ± 0.011	0.91 ± 0.007
SMO	SVM	79.0 ± 0.8	89.4 ± 1.1	27.6 ± 4.5	0.68 ± 0.011	0.74 ± 0.009
Matlab SVM	SVM	91.2 ± 3.8	96.8 ± 3.9	80.8 ± 7.5	0.90 ± 0.039	0.95 ± 0.038

- Sampling rate = 133 Hz
- Spatial resolution = 2540 lpi

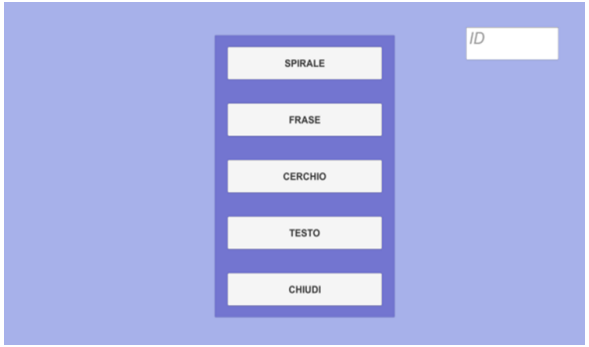
Digital pen Wacom One, model CP913300B2Z

Lenovo ThinkPad T495 laptop (Windows 10)

Professionale graphic tablet with integrated display Wacom One, model DTC133

Data acquisition software

''Drawing App''



'' Drawing App '' home screen.

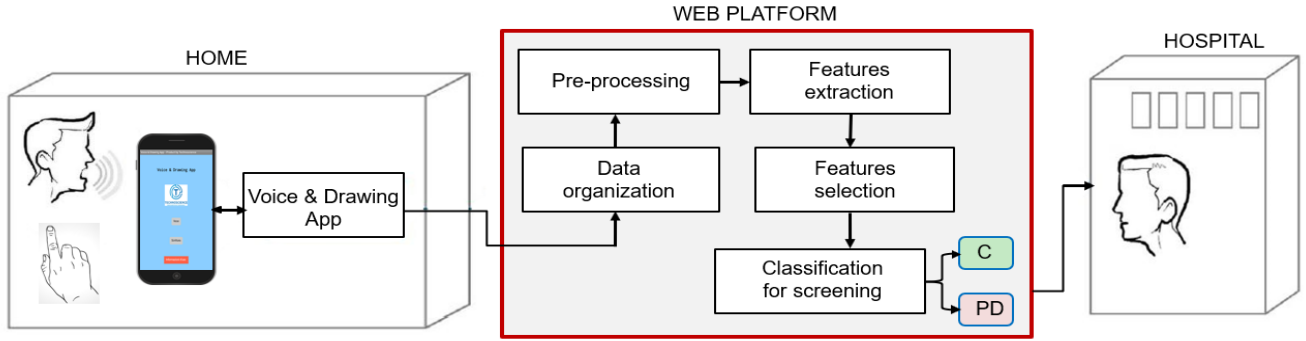
''Classification-Based Screening of Parkinson's Disease Patients through Graph and Handwriting Signals'', Fratello et al., 2021.

Software per analisi dati

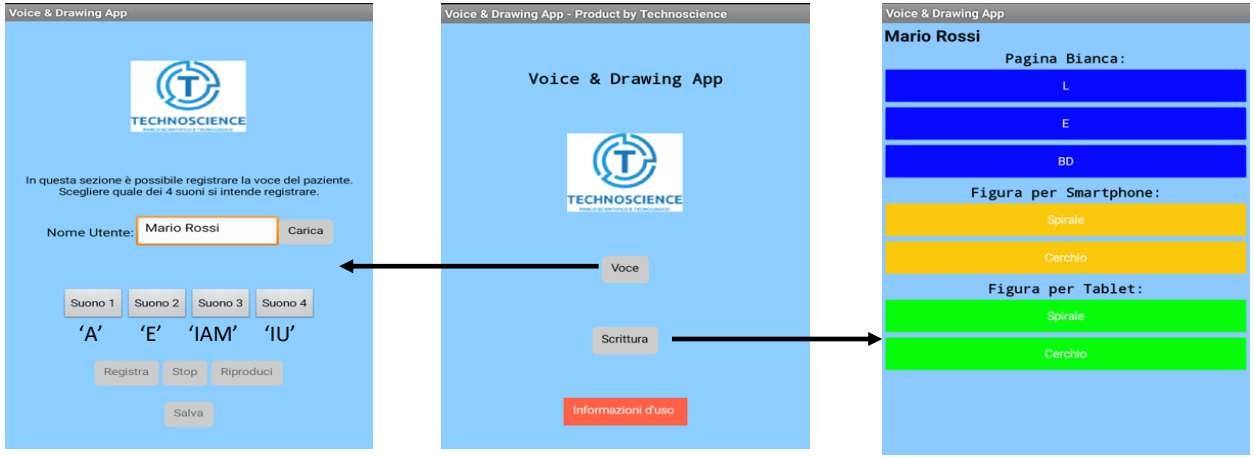
MATLAB

Data organization and pre-processing → Features extraction and selection → Model building with the ''Classification Learner App''

Framework



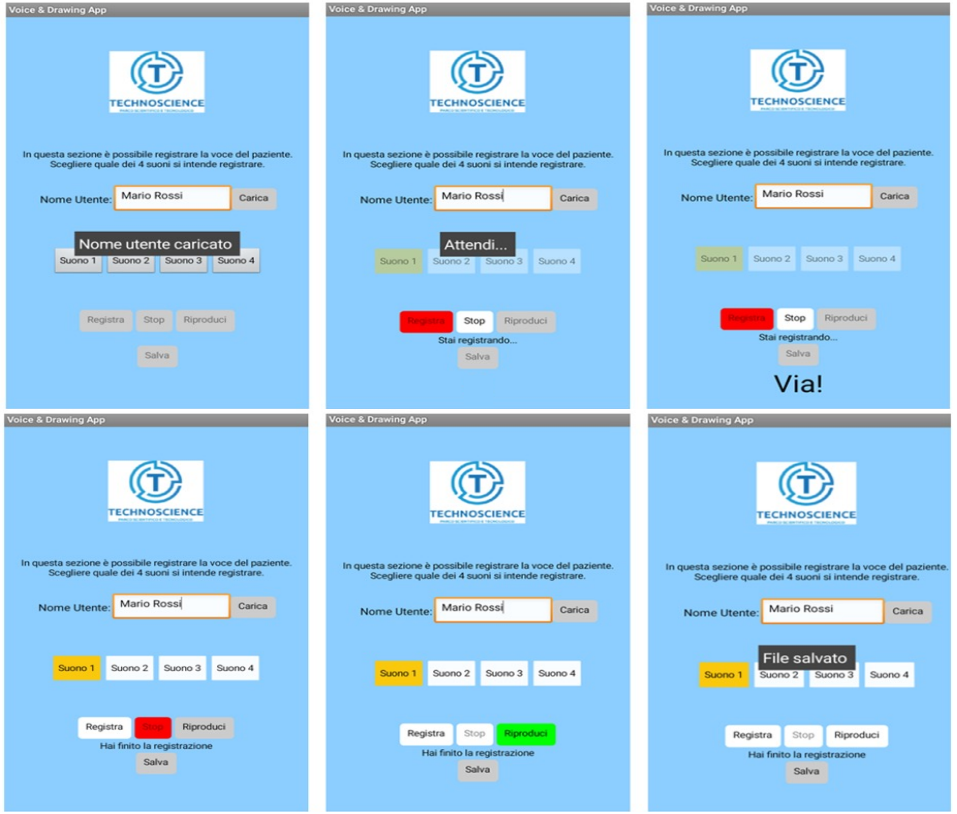
Protocol



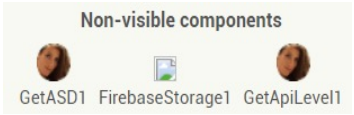
Voice screen

Components not visible:

- *Notifier*
- *Clock*
- *Player* → long sounds
- *Sound* → short sounds
- *WavSoundRecorder* → wav sound.



Saving recordings

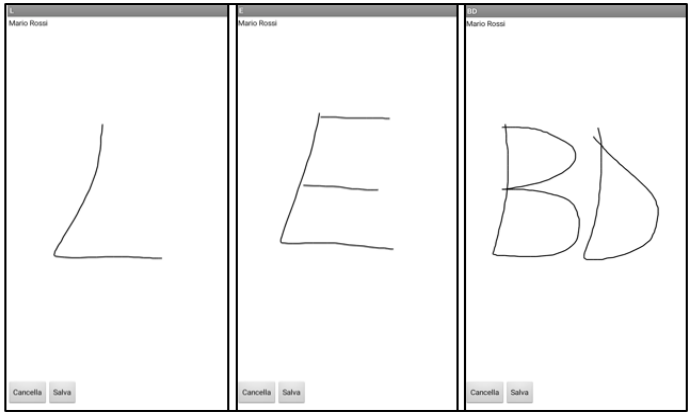


- ✓ Web platform
- ✓ Internal memory

MIT APP INVENTOR

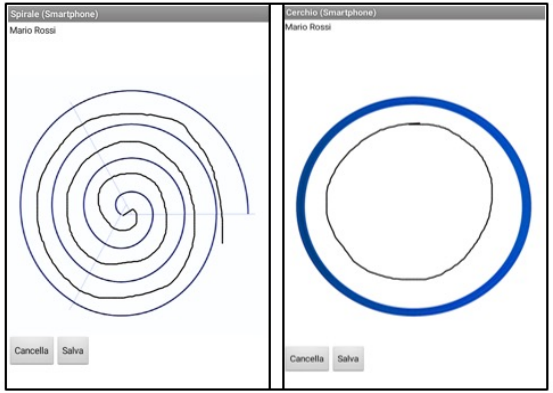
Drawing/writing screen

Canvas



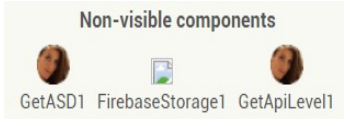
Image

Canvas



Saving images

MIT APP INVENTOR



- ✓ Web platform
- ✓ Internal memory

Risultati

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Mancini. A., Calabrese R., Angelucci M., Albani G., Veneziano G., Mazza M., Marano G., Paffi A., Pallotti A. (under review)

	Spiral	le	Spiral and le
Model	Subspace KNN	Medium KNN	Subspace Discriminant
Accuracy	74,4%	88,4%	93%
Sensitivity	41,7%	75%	83,3%
Specificity	87,1%	93,5%	96,8%
Precision	55,6%	81,8%	90,9%
AUC	0,72	0,93	0,97

	C'	PD'
C	31	
PD	3	9

(a)

	C'	PD'
C	30	1
PD	6	6

(b)

	C'	PD'
C	30	1
PD		12

(c)

Conclusioni

- Dati accessibili per il consulto e l'assistenza da remoto.
- Intervenire tempestivamente da casa e indirizzare i pazienti con sintomi precoci verso esami strumentali in ospedale.
- Avere dati clinici e strumentali su una piattaforma, può impattare in maniera positiva sulle risorse degli ospedali.
- I pazienti possono ridurre il numeri di accessi in ospedale per i controlli

Sviluppi Futuri

- Sviluppare un modello unico di apprendimento automatico voce-scrittura
- Sviluppare un modello di apprendimento automatico multiclasse

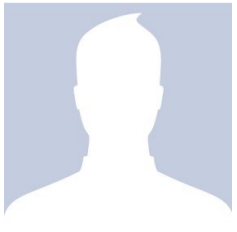
Thank you for the attention! Questions?

Team

Francesca Laganaro (Master student)

Raffaella Calabrese (Health Economist)

Annalisa Mancini (Biomedical Engineer)



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