Lower-Limb Falling Detection System Using Gated Recurrent Neural Networks

Francisco Luna-Perejón, Luis Muñoz-Saavedra, Javier Civit-Masot, Juan M. Montes-Sánchez, Manuel Domínguez-Morales and Anton Civit
Robotics and Computer Technology Lab
Avda. Reina Mercedes s/n, E.T.S. Ingeniería Informática, Universidad de Sevilla, Sevilla, Spain
Email: {fralunper, luimunsaa, jcivit, jmontes, mdominguez, civit}@atc.us.es

Fall Detection and Prevention

- Older people are very likely to suffer falls.
- Falls are a major cause of disability
- The paper presents an intelligent embedded device for fall detection
- The system distinguishes between activities for daily life , falls and risk of falling.

TABLE I. TYPE OF ACTIVITIES RECORDED.

Parameter	Set of values for grid search
ADL	
Activity 1	The subject sits down on a chair.
Activity 2	The subject gets up from a chair.
Activity 3	The subject walks calmly.
Activity 4	The subject goes down the stairs.
Activity 5	The subject goes up the stairs.
Activity 6	The user trips over with the right foot.
Activity 7	The user trips over with the left foot.
Falls	
Activity 8	The user falls backwards.
Activity 9	The subject falls to the left.
Activity 10	The subject falls to the right.
Activity 11	The subject falls forward.

Architectures

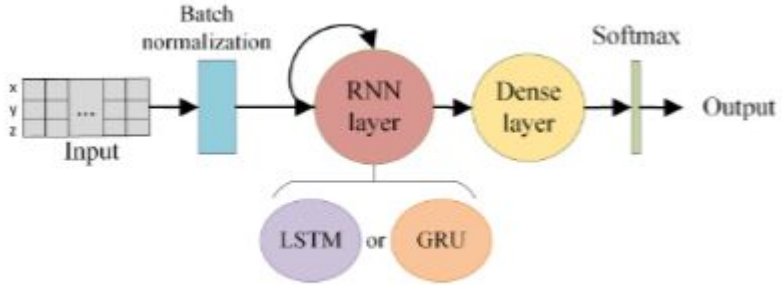

Figure. 2. Diagram of the Gated RNN architectures assessed.

TABLE II. GRID SEARCH VALUES FOR EXHAUSTIVE PARAMETERS OPTIMIZATION.

Parameter	Set of values for grid search
Learning rate	0.0001, 0.0005, 0.001
Batch size	32, 64
Number of nodes	16, 32, 48
Dropout	0.15, 0.25

Results

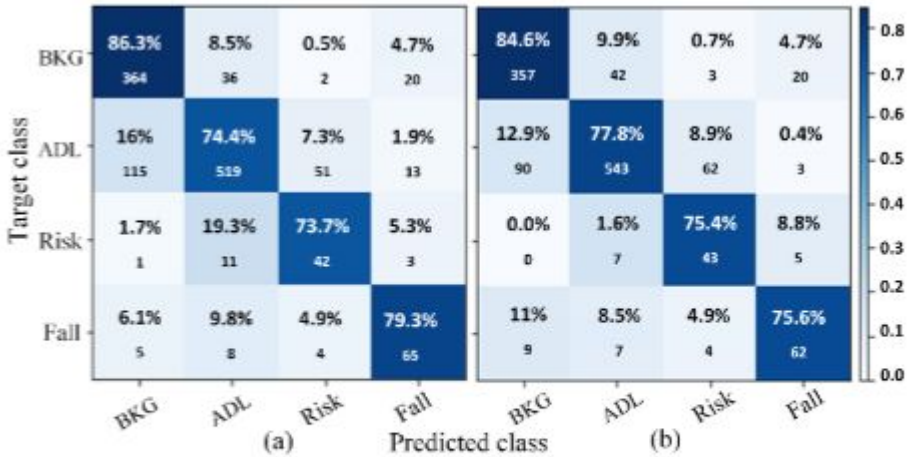

Figure. 3. Confusion matrices for the LSTM model in (a) and GRU model in (b).

TABLE IV. RESULTS OBTAINED AFTER GRID SEARCH OPTIMIZATION.

RNN type	$Precision_m$	$Recall_m$	$Specificity$	$F1score_m$
LSTM	0.681	0.784	0.920	0.729
GRU	0.691	0.790	0.925	0.737

Conclusions

The performance reached with simple LSTM and GRU models indicates the feasibility to extract features to identify ADL, falls and risk events (in falling detection systems). This work demonstrates that FDS can be placed in the lower limbs in order to combine the information obtained from it with Gait Analysis Systems (GAS). This is the main novelty of this work.

However, in order to improve the results obtained in this work, it is necessary to deepen into these systems with more complex architectures and larger datasets, as well as in the application of appropriate data preprocessing techniques.