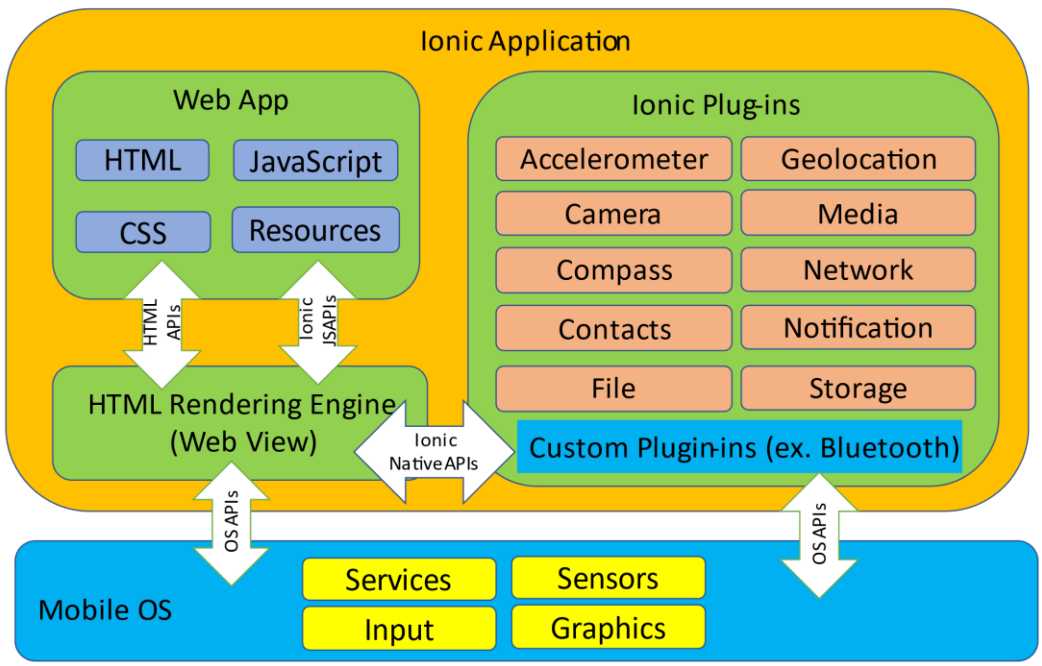
Supplementary Material

For the mobile application (APP) in the wearable-device assisted rehabilitation (WEAR) system, we implemented the Ionic Framework as a platform that can produce cross-platform mobile APPs based on HTML, CSS, and JavaScript. Using the Ionic tool, we could easily write an APP on smartphones with different operating systems (Supplemental Figure 1). By using the plug-in API bridges, we achieved a functionality connection between the WebView powering the Ionic APP and the native platform on which the smartphone APP could perform.



Supplemental Figure 1. Ionic Framework diagram of the WEAR system.

A. Proposed Rehabilitation Programs

We adapted the following six assisted rehabilitation programs for the trunk and upper and lower limbs in accordance with the practice of therapists for the rehabilitation of acute stroke patients (Supplemental Figure 2 a-f).

(a) *Lifting*

Sit upright and hold the phone with both hands on the knees horizontally.

Raise the hands slowly.

Try to raise the hands over the head.

Continue holding the phone with the hands and placing the hands downward to the chest slowly, and then return to the original posture.

(b) *Spinning up*

Place one hand on your knee and hold it on the phone in the affected hand.

Move the hand toward the opposite ear.
Stop the hand when it rests beside the ear.

(c) *Reaching the floor*

Sit upright and hold phone with both hands on the knees horizontally.
Try to place the hands toward the floor.
Continue holding the phone with the hands and slowly stretch forward and below the chair.

(d) *Knee extension*

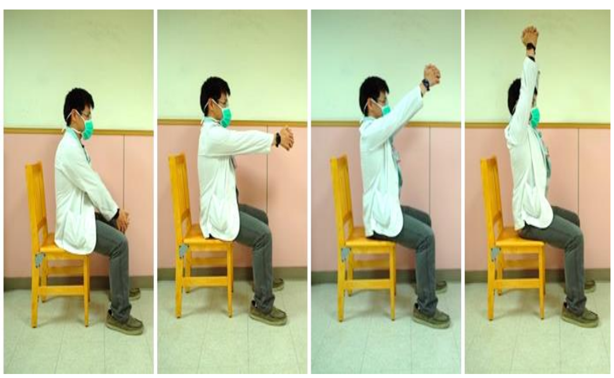
Sit upright on a sturdy chair.
Attach the rubber band on the lower legs with the phone inside the pocket facing anteriorly.
Extend the knee as if kicking as far as possible.

(e) *Hip abduction*

Stand against a bench or table and hold it for balance.
Attach the rubber band on the lower legs with the phone in the pocket facing laterally.
Slowly lift the affected leg out to the side and then down again.

(f) *Bridging*

Lying flat on the bed with knees bent and feet on the bed or mat, lift the hips.
Attach the rubber band on the upper thighs with the phone inside.
Lift the buttocks toward the ceiling slowly until the back is straight and then down again.



(a)

(b)

(c)

(d)

(e)

(f)

Supplemental Figure 2. Step diagrams of the (a) raising motion, (b) spinning up, (c) reaching to the floor, (d) knee extension, (e) hip abduction, and (f) bridging exercise.

B. Motion Capture Algorithm

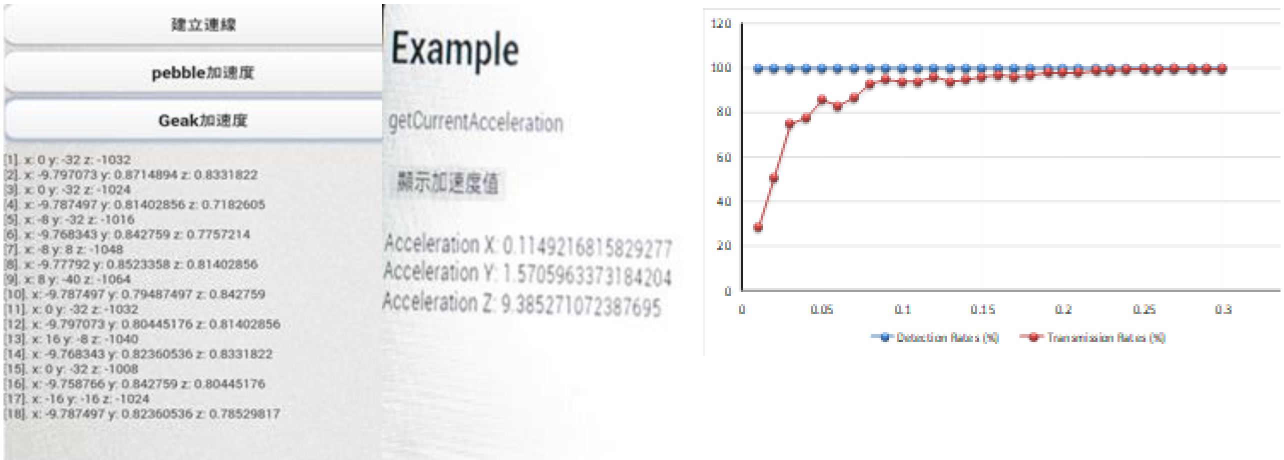
Motion capture of the standard movements of the six assisted rehabilitation programs was performed by the senior therapists 10 times while holding the smartphones or wearing smartwatches. This was performed for different parts of the trunk and upper and lower limbs (Supplemental Figure 3). The boundaries of each rehabilitation program were determined by the upper and lower limits of the recorded values (Supplemental Figure 4). The values for the common erroneous movements of acute stroke patients were demonstrated by the therapists 10 times. The boundaries of each rehabilitation program were determined using the upper and lower limits of the recorded values. When the screens of the smartphone on the palm and watch on the wrist were facing different directions, different values of the triaxial accelerometer were recorded.

(a)

(b)

(c)

Supplemental Figure 3. Motion capture for (a) reaching to floor, (b) lifting, and (c) bridging.



(a) (b) (c)

Supplemental Figure 4. Detection of the accelerometer values using motion capture by the (a) smartphone and (b) smartwatch. (c) Detection rates of smartwatches and transmission rates of the smartphones and smartwatches.

C. Algorithm: Executing an APP-assisted Rehabilitation Program

Input: Motion trial of the rehabilitation program: motion_trial[i]= motion_trial[1], motion_trial[2],...motion_trial[n], where each motion_trial[i] is a pair of sensor values of the triaxial accelerometer and the gyroscope ([Ax1, Ay1,Az1], [Ax2, Ay2, Az2]),([Gx1, Gy1,Gz1], [Gx2, Gy2, Gz2]).

Output: Success or Fail
Start timing
For (each motion_trial[i]) do
Repeat

Periodically obtain the sensor values from the connected bracelet: Pos = ([Ax, Ay, Az], [Gx, Gy, Gz])

If Ax1 <= Ax <=Ax2 and

Ay1 <= Ay <=Ay2 and

Az1 <= Az <=Az2 and

Gx1 <= Gx <=Gx2 and

Gy1 <= Gy <=Gy2 and

Gz1 <= Gz <=Gz2

Then

```
        // Pos is within motion_trial[i].
        match = TRUE;
    Else
         match = FALSE
    End If
  Until match
End For
Return Success
```

D. Outcome measurement

The APP-assisted rehabilitation programs were externally validated by an independent therapist who was not involved in the development stage. We performed a comparison of different systems to examine whether different embedded sensors of can run the APP with similar performance on smartphones and smartwatches**.** The sensitivity and specificity were determined by performing standard correct and incorrect motions by the independent therapist. The overall results of the external validation are listed in Supplemental Table 1.

Supplemental Table 1: Sensitivity and Specificity of Smartphones and Smartwatches Validated by an Independent Therapist

		Lifting	Reaching to the Floor	Spinning Up (shoulder)	Spinning Up (ear)	Knee Extension	Hip Abduction	Bridging	Mean
iOS	Sensitivity	100	100	100	100	100	100	100	100
	Specificity	100	100	100	100	100	100	100	100
Android	Sensitivity	100	100	100	90	100	100	100	98.6
	Specificity	100	100	100	100	100	100	100	100
iOS/Pebble	Sensitivity	100	100	100	100	100	100	100	100
	Specificity	100	100	100	100	100	100	100	100
Android/Pebble	Sensitivity	100	100	100	100	100	100	100	100
	Specificity	90	100	100	100	100	100	100	98.6