Robots for Disability: EEG Operated Water Drinking System

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EEG Operated Water Drinking System

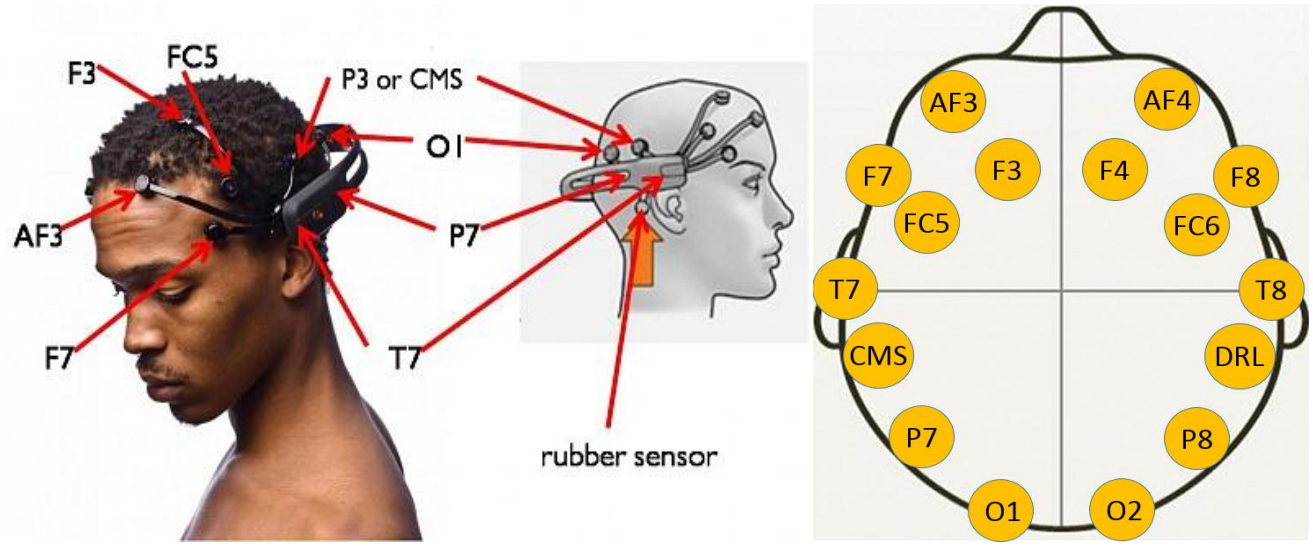
- Purpose: To assist people with quadriplegia in drinking autonomously.
  - –Because people with this severe of a disability are unable to move their arms and legs, they require caregiver assistance to drink and eat.
  - –By using an Emotiv EPOC EEG machine, we are able to reliably detect eye blinks through brain signals in the cap.
  - –Using a Raspberry pi 2, we constructed a system with an automatic drinking straw that is triggered by a specified series of blinks based on timing intervals between the blink.
  - –The drinking system was built conventional mechatronics parts with a Raspberry Pi that has a filtering system on the EEG sensor output to detect blinking

EEG Operated Water Drinking System

•EEG headset device (Emotiv EPOC)

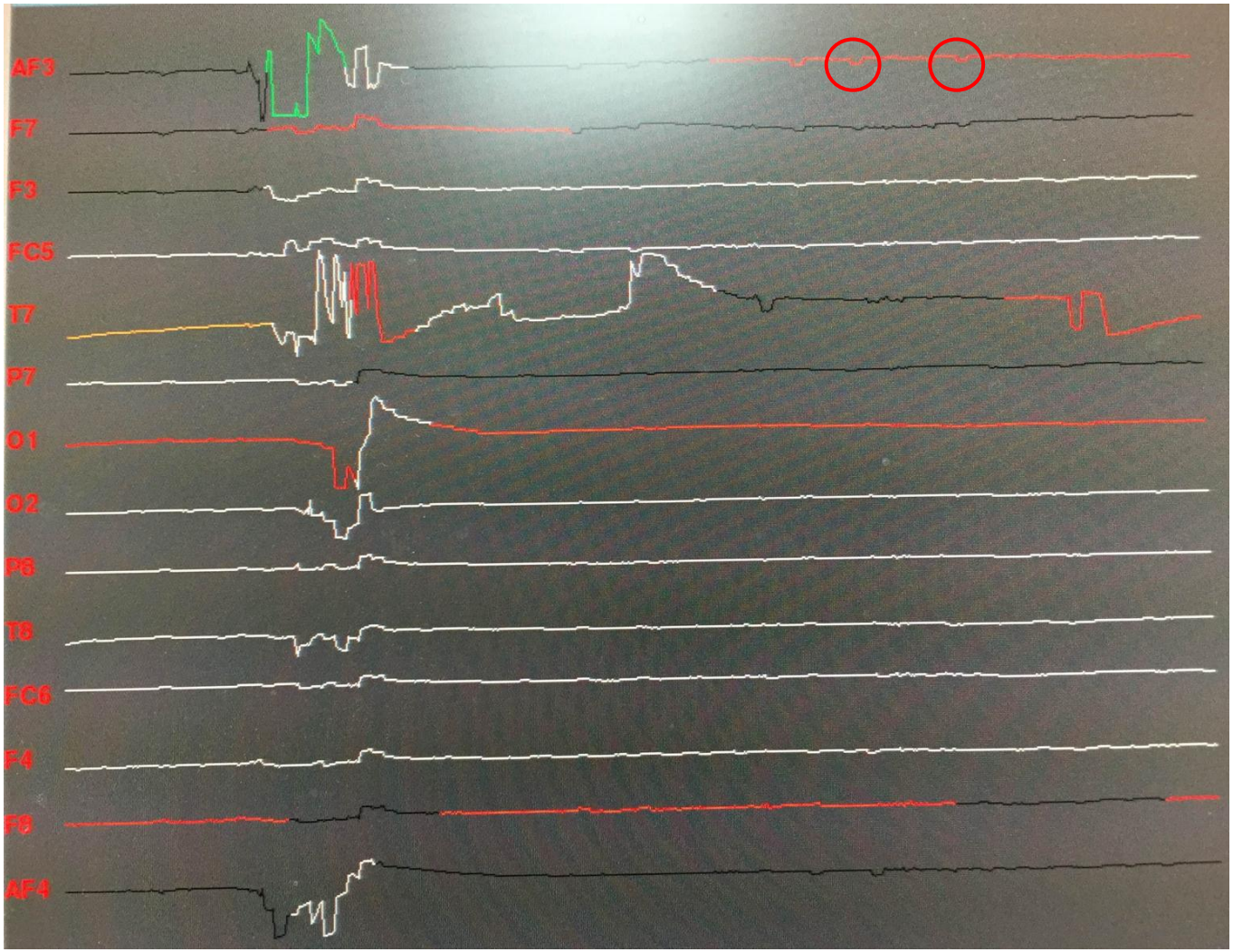
- 14 EEG channels + 2 references
- Channel location:

  AF3, F7, F3, FC5, T7, P7, O1, O2, P8, T8, FC6, F4, F8, AF4
- Uses sequential sampling method, single ADC, at a rate of 128 SPS

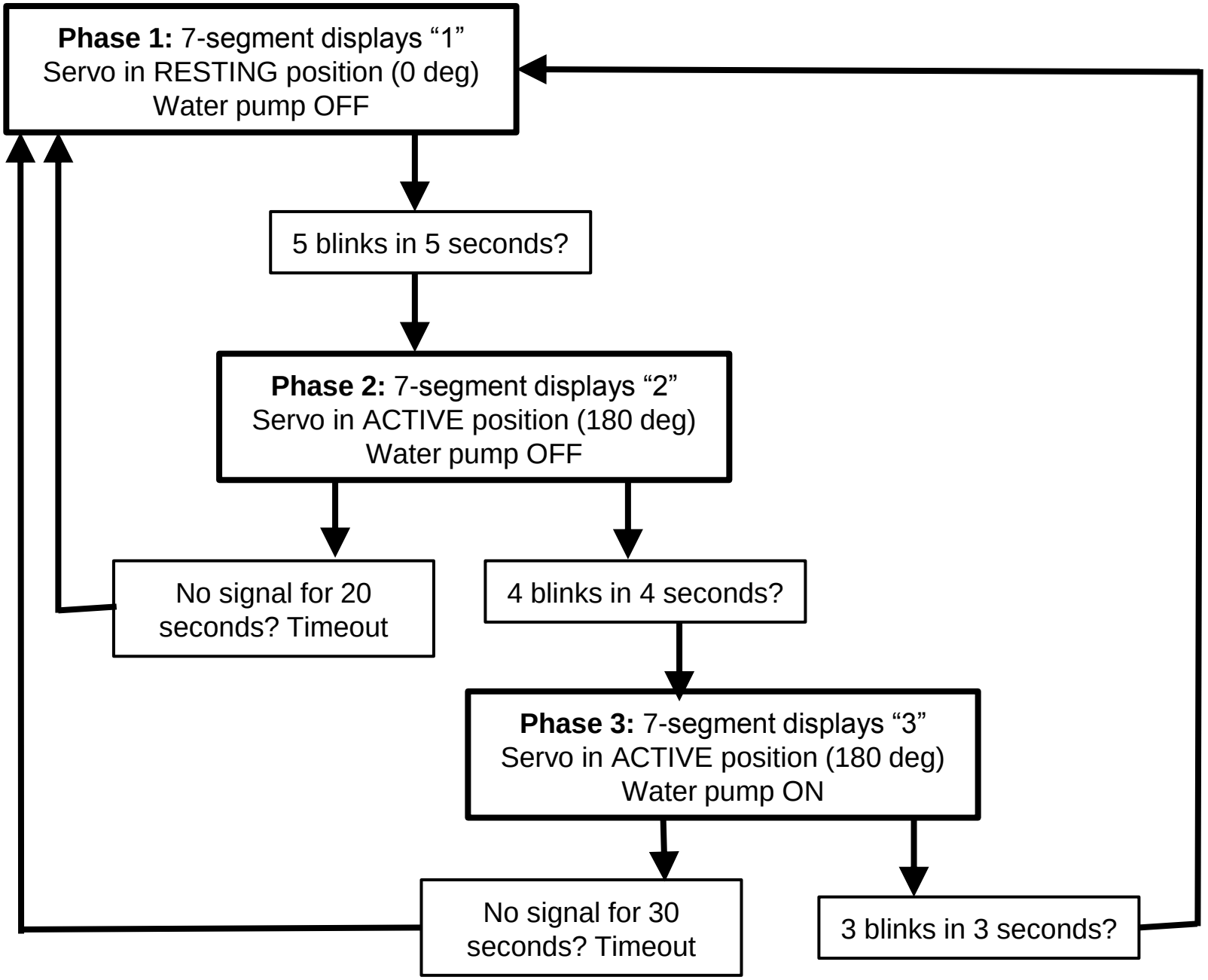


Blinking

•Data for all EEG sensors displayed in real time on Raspberry Pi with a Python graphing program for data visualization

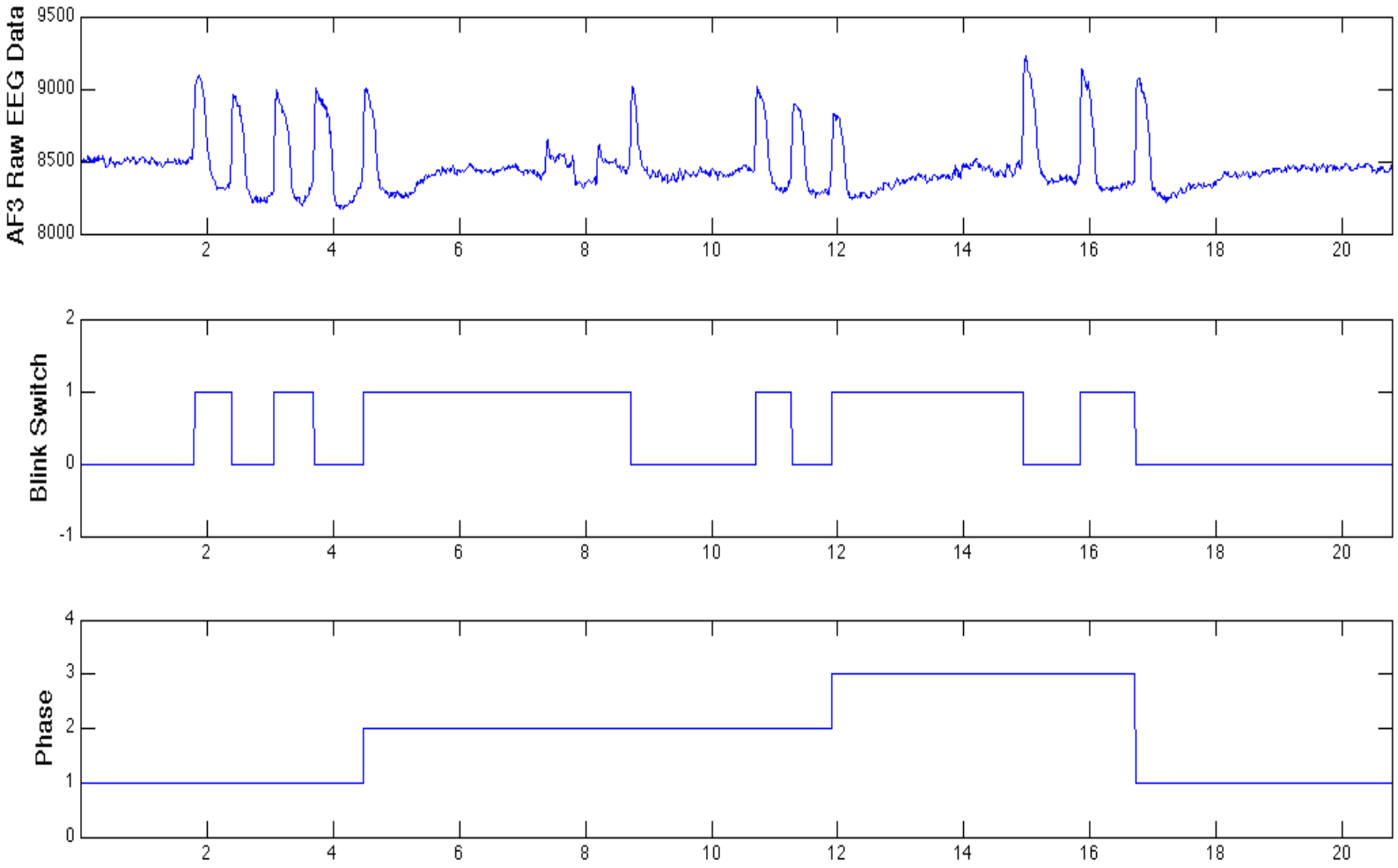


Blinking Phase Flowchart



Blinking Phase Simulation

- Phase system: Matlab plots show virtual blinking machine



Blinking Phase Python Code

Filter data for blink to establish switch:

```
if (testmat[9,1]-testmat[2,1]) > 300 and count == 40: #if a blink occurs
if switcher == True: #this statement reverses switch position when blink occurs
    switcher = False
    GPIO.output(25,GPIO.LOW)
    count = 1
elif switcher == False:
    switcher = True
    GPIO.output(25,GPIO.HIGH)
    count = 1

for y in range(1, 5):
    timeque[y,0]=timeque[y+1,0]
    timeque[y,1]=timeque[y+1,1]

timeque[5,0]=testmat[9,0]
timeque[5,1]=testmat[9,1]
```

Search for sequence to change phase:

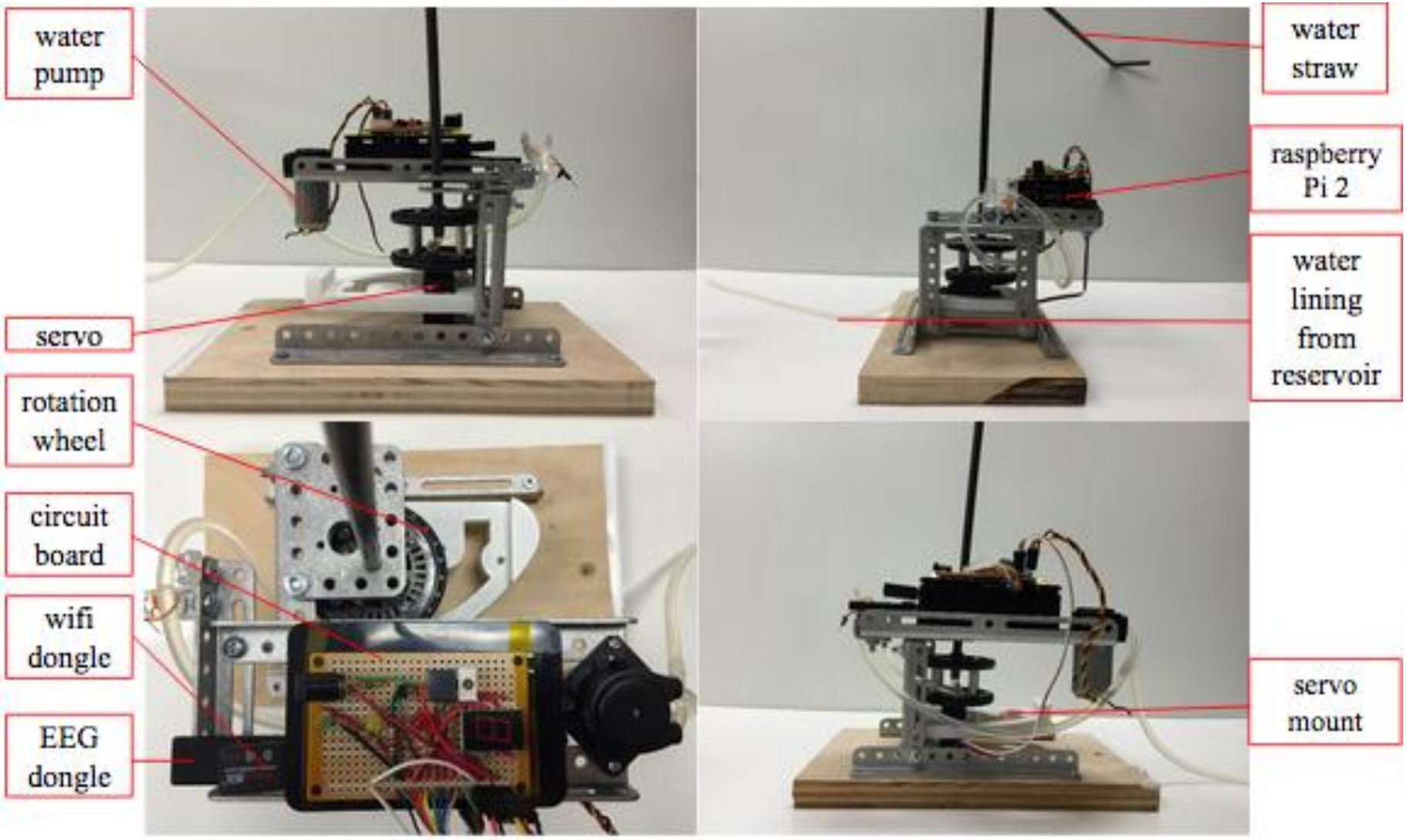
```
if phase == 1:          #establish test for servo rotation: look for 5 blinks
    GPIO.output(5,GPIO.LOW)
    GPIO.output(6,GPIO.LOW)
    GPIO.output(12,GPIO.LOW)
    GPIO.output(13,GPIO.HIGH)
    GPIO.output(16,GPIO.LOW)
    GPIO.output(26,GPIO.LOW)
    if  timeque[1,0]==0:

    #for all cases where the time que isn't full continue filling
    timeque[0,0]=0
    elif (timeque[5,0]-timeque[1,0]) >= threshold1 and timeque[1,0] > 0:

    #too long, minor timeout. clear queue
    timeque[0,0]=0
    timeque[0,1]=0
    timeque[1,0]=0
    timeque[1,1]=0
    elif (timeque[5,0]-timeque[1,0]) < threshold1 and timeque[1,0] > 0:

    #rotate servo go to next phase of blinking
    phase=2
    turntime=timeque[5,0]
    timeque = numpy.zeros((6,2))
```

Move servo:

```
if phase == 1:
duty = float(175) / 10.0 + 2.5
    pwm.ChangeDutyCycle(duty)
elif phase == 2:
duty = float(5) / 10.0 + 2.5
    pwm.ChangeDutyCycle(duty)
elif phase == 3:
duty = float(5) / 10.0 + 2.5
    pwm.ChangeDutyCycle(duty)
```

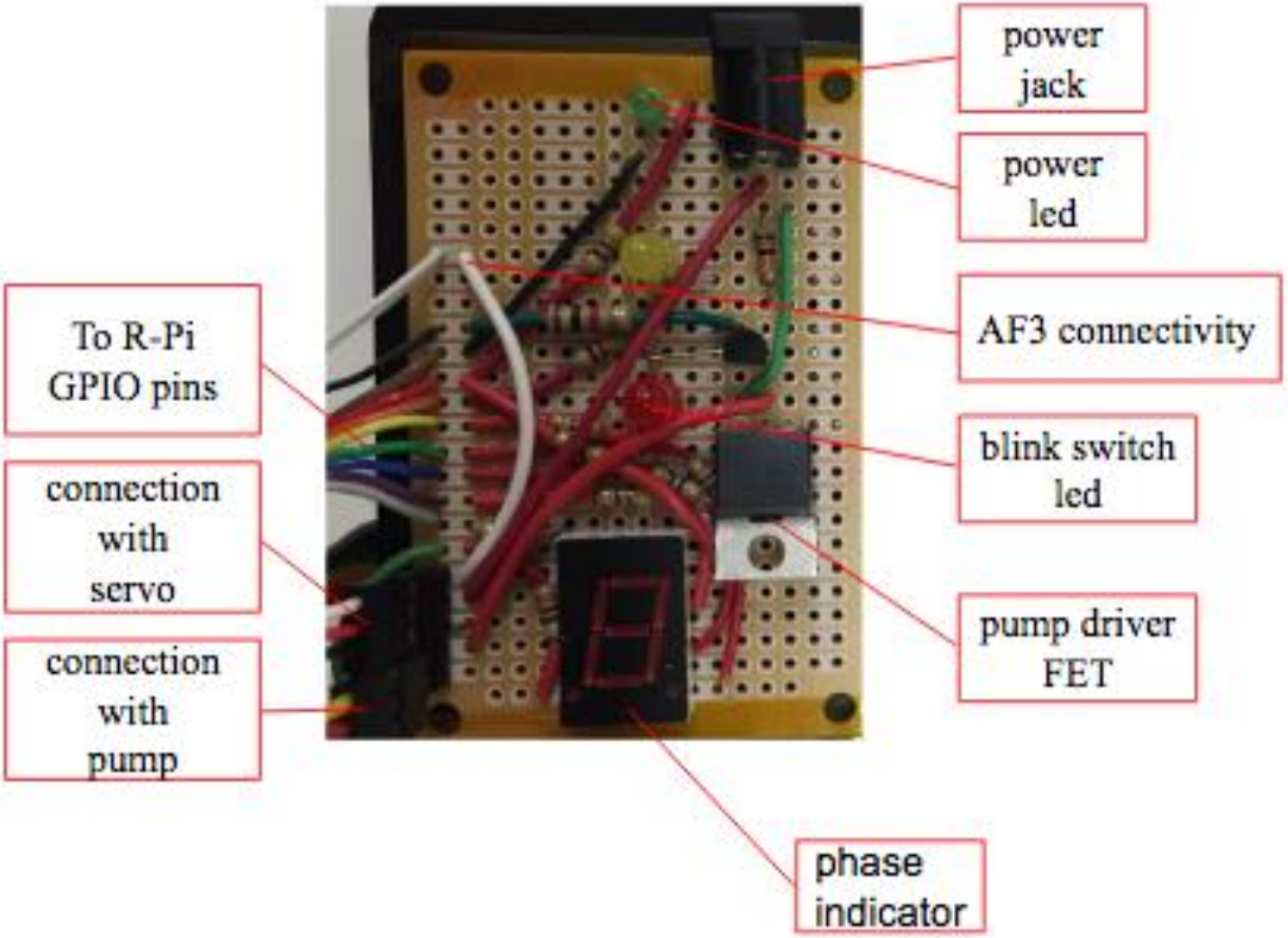
EEG Operated Water Feeder

- System Construction (Hardware)



Display Board

•System Construction (Bread board)



Project costs

Material	cost
EEG headset device	$399
Raspberry pi 2 with starter kit	$69.99
Circuit & board components	Free (from ADOL lab)
Hardware design components_Frame	Free (from Mechatronics lab)
Hardware design components_Bolt & Nuts	$11.99
Peristaltic Liquid Pump (Adafruit)	$38.81
Acetal Resin Tube (Straw)	$11.70
Water reservoir	Free
Standard servo (Parallax)	Free (from mechatronics kit)
Total	$531.49

EEG Operated Drinking System: Video