Towards a Comprehensive and Lightweight User State Monitoring System on Android Smartphones

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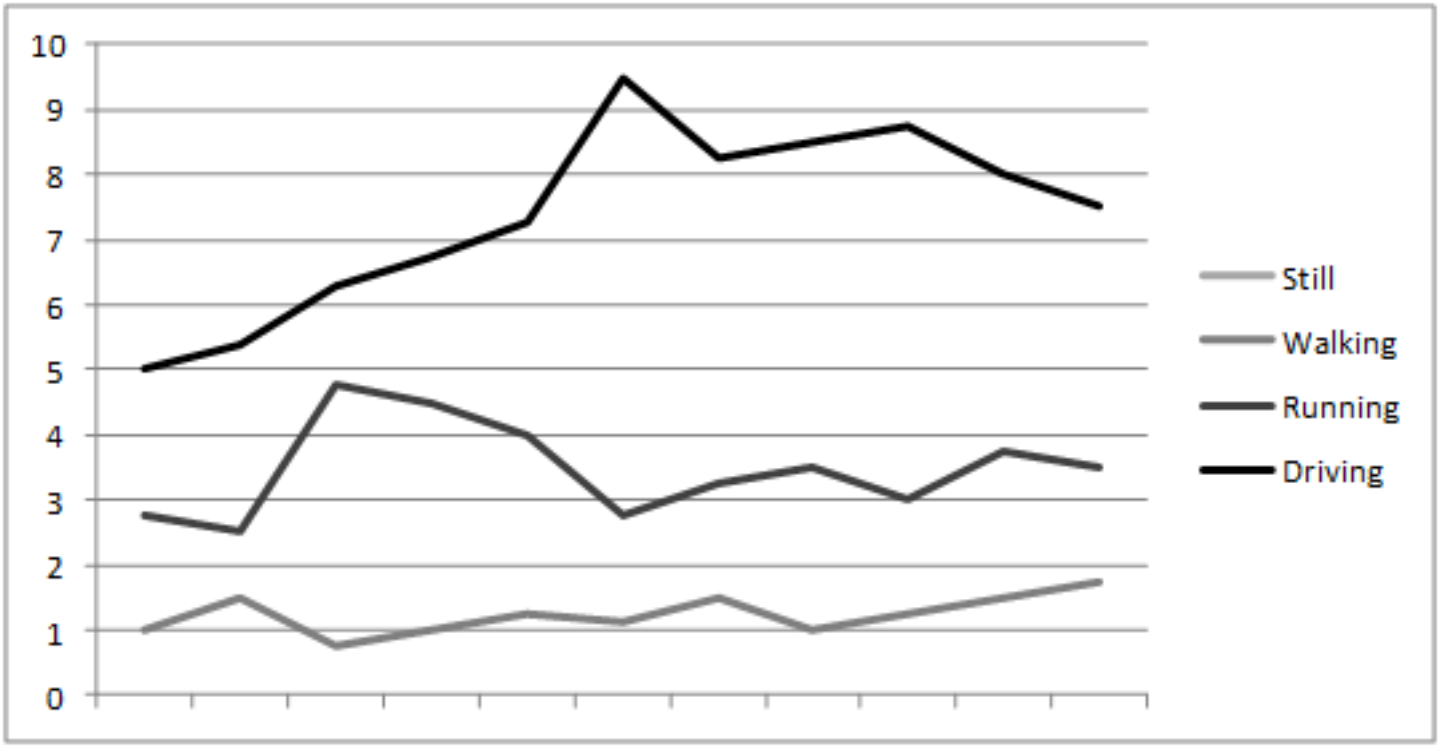
Outline

- Motivation
  - Non-intrusive
  - Physical state monitoring
  - Mental sate monitoring
- Algorithms for user state monitoring
  - Outdoor
  - Indoor
  - Mood
- Prototype implementation
- Evaluations
- Conclusions and Future work

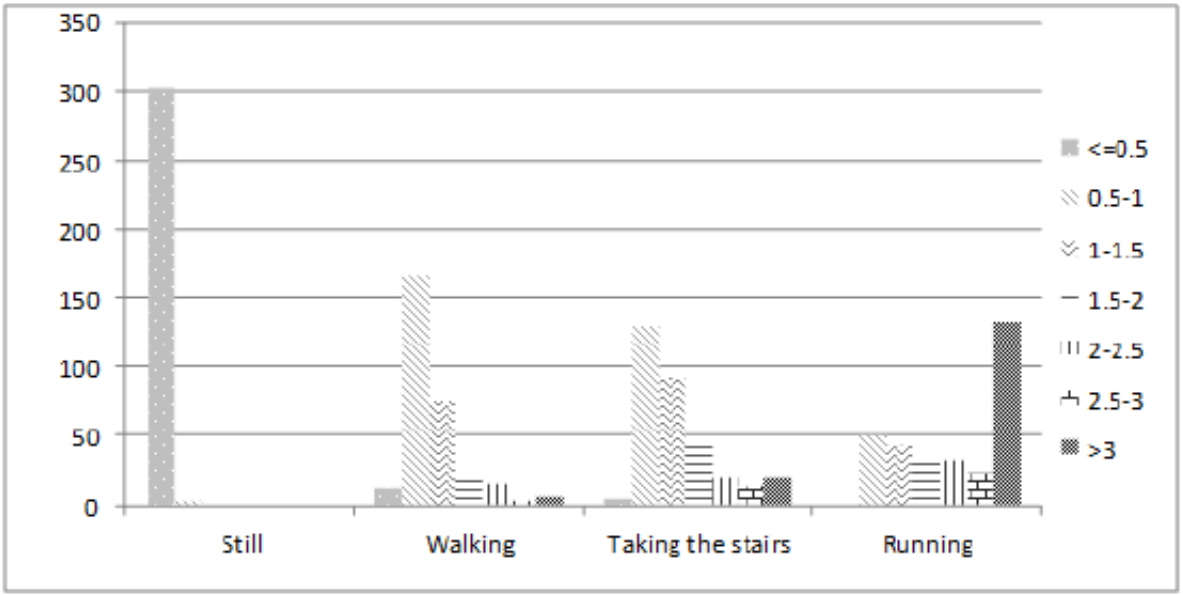
GPS based outdoor activity recognition



Accelerator based indoor activity monitoring

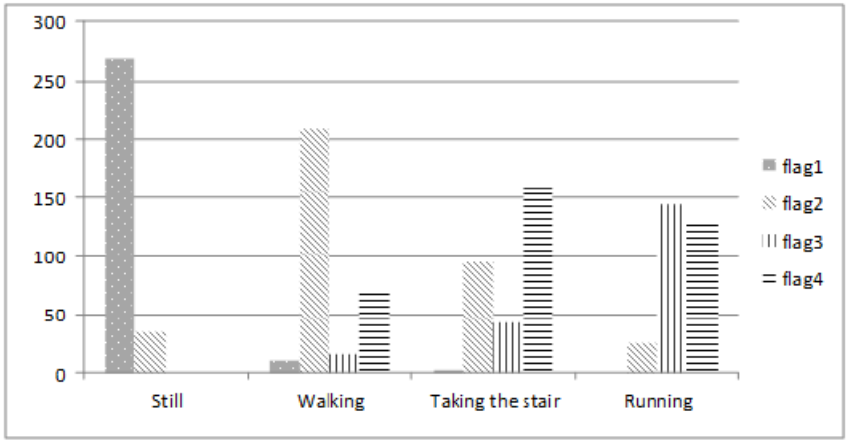
- Basic assumptions and facts:
- Different physical activity will show different acceleration features:
  - The ‘still’ state will have the least acceleration fluctuations;
  - while in walking, there will be a greater acceleration fluctuation than that in the still state
  - For running state, the fluctuations be the greatest.
- The position and location should not matter

Distribution of accelerations



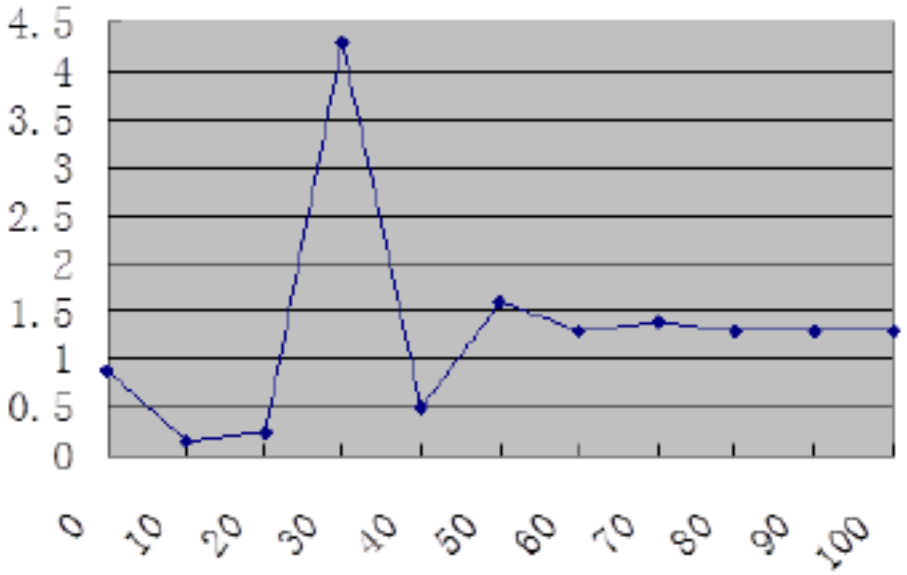
- for the still state, the majority of the absolute acceleration values are less than 0.5 m/s^2.
- For the walking activity, the majority of the acceleration values are between 0.5 and 2.5.
- For the running state, the largest proportion of acceleration values are greater than 2.5.

Indoor recognition

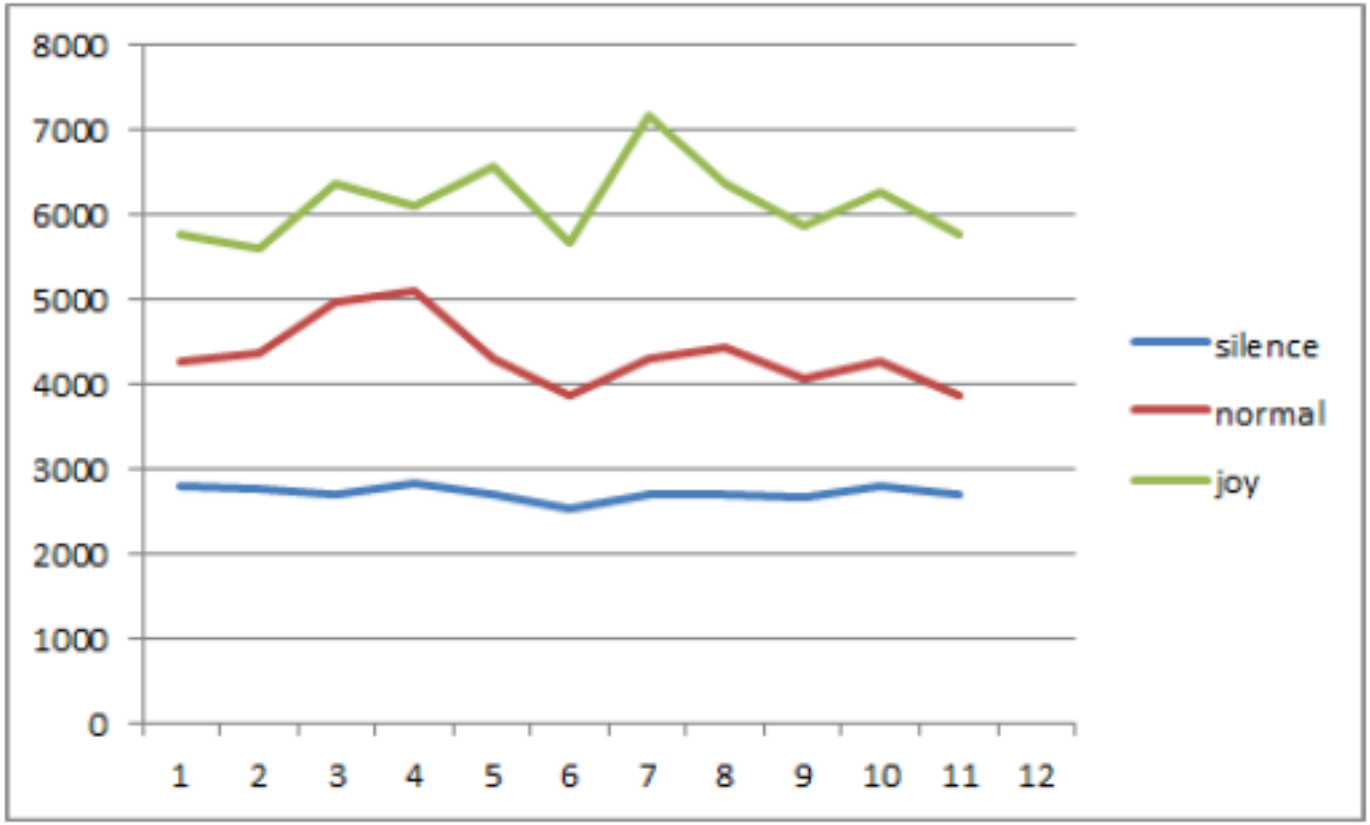



```
if(abs(x)<=0.5&&abs(y)<=0.5&&abs(z)<=0.5)
 {
   flag1++;//the number of 'still' state
   k++;
 } else
if (abs(x)>0.5&&abs(x)<=0.5||abs(y)>0.5
  &&abs(y)<=2.5||abs(z)>0.5&&abs(z)<= 2.5)
  {
   if((abs(x)>1&&abs(y)>2)||(abs(y)>1&&abs(z)> 2)
   || (abs(x) > 1 && abs(z) > 2))
   {
    flag4++; //the number of 'taking the stairs'
    flag2--;
                }
   flag2++; //the number of 'walking'
   k++;
  } else
if (abs(x)>2.5||abs(y)>2.5|| abs(z)>2.5)
  {
     flag3++;//the number of 'running'
     k++; //the number of total measurements
  }
if (k > 10)
  {
  if(flag1>flag2&&flag1>flag3&&flag1>flag4)
 {
  IN STILL STATE
 }  else
 if (flag2 >flag1&&flag2>flag3&&flag2>flag4)
       {
  IN WALKING STATE
 } else
 if (flag3>flag1&&flag3>flag2&&flag3>flag4)
 {
  IN RUNNING STATE
 } else
 if (flag4>flag1&&flag4>flag2&&flag4>flag3)
 {
  IN TAKING STAIRS STATE
 }
}
```

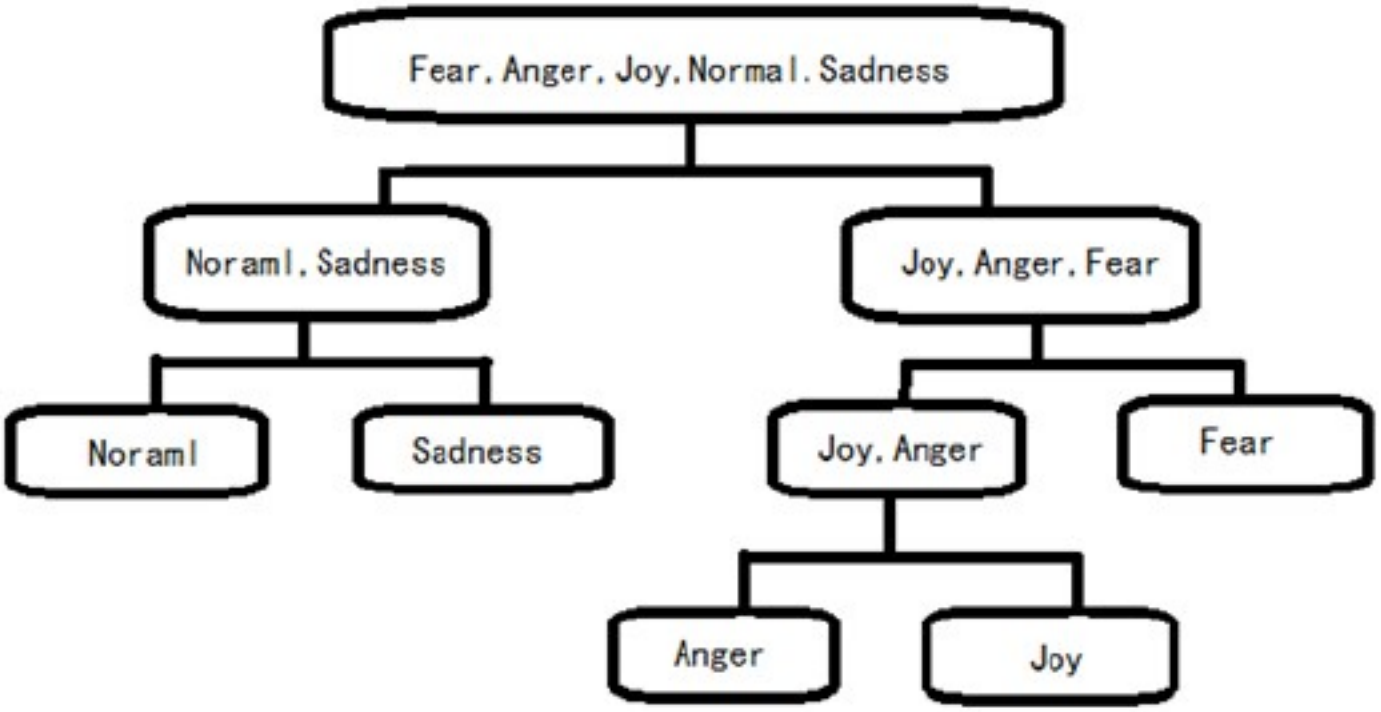
Falling down detection



White noise for different mood



Decision tree for mood recognition



Mood recognition algorithm

```
if (flag1/kk>= 0.2) {
                    if (flag1 / kk < 0.4) {
                            IN FEAR
                    } else
                    if (flag1 /kk >= 0.4&& average >= 4500
                                    && average <= 5500)
                                    {
                            IN ANGER
                    } else
                    if (flag1 / kk >= 0.4&& average >= 5500)
                    {
                            IN JOY
                    } else {
                            NOT RECOGNIZABLE
                    }
            } else {
                    if (flag2 / kk >= 0.4|| flag3 / kk >= 0.4
                                    && average >= 3800)
                     {
                            NORMAL
                    } else
                    if (flag3 / kk >= 0.5&& average <= 3800) {
                            IN SADNESS
                    } else {
                            NOT RECOGNIZABLE
                    }
            }
```

Evaluations

- Accuracy

											Accuracy
Still	y	y	y	y	y	y	y	y	y	y	100%
Walking	y	y	y	y		y	y	y	y	y	90%
Go stairs	y	y	y	y	y	y	y		y	y	90%
Running	y		y		y	y	y	y	y	y	80%

Time taken for recognizing activity switching

	still	walking	taking stairs	running
still		368	622	501
		193	698	98
		297	354	298
		301	436	293
		94	188	101
average		250.6	459.6	258.2
walking	205		532	398
	201		299	165
	297		165	100
	100		301	100
	196		298	499
average	199.8		319	252.4
running	894	307	765	
	698	300	587	
	1800	200	309	
	802	402	679	
	895	697	319	
average	1017.8	381.2	537.8	
taking stairs	288	375		638
	451	531		454
	399	831		521
	657	342		437
	621	426		528
average	483.2	501		515

Battery consumption

- Measured using powertutor

Acc.	LCD	CPU	Mic.	LCD	CPU	GPS	LCD	CPU
61.1	54.6	5.5	61.7	58.5	3.2	56.2	54	2.2
55.2	50.3	4.9	61.2	57.6	3.6	53.3	52.1	1.2
55.5	50.4	5.1	63.1	59.4	3.7	57.6	55.8	1.8
58.4	53.1	5.3	60.2	56.7	3.4	53.3	52.1	1.2
62	56.7	5.3	61.2	57.6	3.6	55.5	53.6	1.9
59.4	54	5.4	62.4	58.7	3.7	56.2	54	2.2
60.4	54.9	5.5	60.2	56.7	3.4	56.7	54.9	1.8
57.5	52.2	5.3	55.3	52.2	3.1	55.8	54	1.8
58.9	54	4.8	58.9	55.8	3.1	57.2	55.6	1.6
59.4	54	5.3	55.2	52.2	3	53.2	52	1.2
58.78	53.42	5.24	59.94	56.54	3.38	55.5	53.81	1.69

Conclusions and future work

- Accuracy is ok
- Performance is good
- Mental status monitoring

Thank you for your time