**Accelerometer behaviours in Android phone**

**Description**

This is the document related with android phone accelerometer about acceleration measurement, velocity measurement, distance measurement, directional differentiate and orientation detection. Several experiments are conducted to determine the reliability of the accelerometer in measurement of respective field. From the data extracted from accelerometer to interpret user action.

**Experiment 1 raw data to interpret movement**

**Objective**

1. To understand how the data change when we move.
2. To understand the axis of accelerometer
3. To understand the behaviours of accelerometer change when the speed is not constant

**Methodology**

1. An android application is written in java and deploy to android phone to read accelerometer reading.
2. The android application will send the data using MQTT protocol to a PC to perform analysis on the data.
3. The android phone is moved in different direction and different orientation.
4. PC will have a python script to receive data from phone and recorded all the data into a file.
5. Another python script to recorded all the data into an excel file for further analysis.

\*\*\* phone using is MI3 [1]

Table 1 stationary phone face upward

|  |  |  |
| --- | --- | --- |
| x-axis | y-axis | z-axis |
| -0.06375 | -0.22261 | 8.806381 |
| -0.02452 | -0.203 | 8.875031 |
| -0.06375 | -0.25203 | 8.875015 |
| -0.02452 | -0.25203 | 8.855408 |
| -0.07355 | -0.24222 | 8.884827 |
| -0.05394 | -0.26184 | 8.767151 |
| -0.04414 | -0.25203 | 8.904449 |
| -0.02452 | -0.28145 | 8.8358 |
| -0.00491 | -0.27165 | 8.786758 |
| -0.11278 | -0.28145 | 8.806381 |
| -0.01471 | -0.28145 | 8.845596 |
| -0.06375 | -0.28145 | 8.904449 |
| -0.16182 | -0.33047 | 8.855408 |
| -0.20103 | -0.35991 | 8.776947 |
| -0.22066 | -0.3501 | 8.776962 |
| -0.25008 | -0.36971 | 8.875015 |
| -0.20103 | -0.36972 | 8.855408 |
| -0.24026 | -0.32068 | 8.786758 |
| -0.22066 | -0.33049 | 8.845596 |
| -0.20103 | -0.39912 | 8.845596 |
| -0.22066 | -0.34029 | 8.943665 |
| -0.16182 | -0.52661 | 8.79657 |
| -0.16182 | -0.70314 | 9.022125 |
| -0.40698 | -1.08559 | 8.953476 |
| -0.25987 | -1.04637 | 8.855408 |
| -0.04413 | -0.44817 | 8.875015 |
| 0.191223 | -0.39912 | 8.79657 |
| 0.181412 | -0.32068 | 8.855408 |
| 0.161804 | -0.34029 | 8.845596 |
| 0.24025 | -0.37952 | 8.8358 |
| 0.171616 | -0.41875 | 8.816177 |
| 0.161804 | -0.42854 | 8.825989 |
| 0.210831 | -0.35991 | 8.855408 |
| 0.161804 | -0.34029 | 8.825989 |
| 0.181412 | -0.40894 | 8.8358 |
| 0.142197 | -0.43835 | 8.855408 |
| 0.191223 | -0.33047 | 8.747543 |
| 0.250061 | -0.35991 | 8.79657 |
|  |  |  |

Table 2 moving in positive x direction

|  |  |  |
| --- | --- | --- |
| X-axis | Y-axis | Z-axis |
| 0.328506 | -0.22261 | 9.051544 |
| 0.328506 | -0.17358 | 9.031921 |
| 0.299088 | -0.19319 | 8.953476 |
| 0.289291 | -0.14417 | 9.06134 |
| 0.299103 | -0.17357 | 9.012314 |
| 0.299103 | -0.13435 | 9.031921 |
| 0.308899 | -0.16377 | 9.002502 |
| 0.250061 | -0.15396 | 9.100571 |
| 0.269669 | -0.16377 | 9.031921 |
| 0.338318 | -0.18338 | 8.973099 |
| 0.328506 | -0.18338 | 8.973084 |
| 0.328522 | -0.10493 | 8.973084 |
| 0.31871 | -0.12454 | 9.012314 |
| 0.328522 | -0.16377 | 8.992706 |
| 0.299088 | -0.16377 | 9.06134 |
| 0.24025 | -0.14415 | 9.031921 |
| 0.24025 | -0.12454 | 8.982895 |
| 0.269669 | -0.13435 | 8.982895 |
| 0.269684 | -0.11473 | 9.071152 |
| 0.299088 | -0.12454 | 9.06134 |
| 0.269684 | -0.15396 | 9.06134 |
| 0.289291 | -0.13435 | 9.061356 |
| 0.250061 | -0.10493 | 9.022125 |
| 0.259872 | -0.19319 | 9.080963 |
| 0.877686 | -0.21281 | 9.012314 |
| 2.02507 | -0.30107 | 8.924057 |
| 0.593292 | -0.39914 | 9.022125 |
| -2.47618 | -0.2128 | 9.198639 |
| -0.34814 | -0.0657 | 9.149597 |
| 0.181427 | -0.05589 | 9.002502 |
| 0.250061 | -0.08531 | 9.071152 |
| 0.269669 | -0.07552 | 9.06134 |
| 0.308899 | -0.0461 | 9.002518 |
| 0.259872 | -0.0461 | 9.051544 |
| 0.289291 | -0.02647 | 9.031921 |
| 0.259872 | -0.0657 | 9.002502 |
| 0.230453 | -0.18338 | 8.502365 |
| 0.181412 | 0.002945 | 8.953476 |
| 0.201019 | -0.07552 | 8.953476 |
| 0.299103 | -0.07552 | 9.090759 |
| 0.259872 | -0.08531 | 9.080963 |

Table 3 accelerometer x negative direction

|  |  |  |
| --- | --- | --- |
| x-axis | y-axis | z-axis |
| 0.250061 | -0.09512 | 8.9730835 |
| 0.250061 | -0.08531 | 9.002502 |
| 0.289291 | -0.08531 | 8.9730835 |
| 0.289291 | -0.07552 | 8.992706 |
| 0.289291 | -0.08531 | 9.100571 |
| 0.299088 | -0.07552 | 9.031921 |
| 0.31871 | -0.02647 | 9.002502 |
| 0.289291 | -0.0461 | 8.982895 |
| 0.299088 | -0.0657 | 9.012314 |
| 0.338318 | -0.11475 | 9.031921 |
| 0.299088 | -0.11473 | 9.031921 |
| 0.328522 | -0.0657 | 9.051544 |
| 0.338318 | -0.0657 | 8.982895 |
| 0.308899 | -0.05589 | 9.002502 |
| 0.289291 | -0.04608 | 9.022125 |
| 0.31871 | -0.0461 | 9.06134 |
| 0.289291 | -0.01666 | 9.071152 |
| 0.289291 | -0.05589 | 8.9730835 |
| 0.289291 | -0.02647 | 8.963287 |
| 0.299088 | -0.05591 | 8.982895 |
| 0.308899 | -0.0657 | 8.992706 |
| -0.61292 | 0.189255 | 9.002502 |
| -2.13295 | -0.09512 | 8.9730835 |
| -0.2991 | -0.19319 | 9.12999 |
| 2.515396 | -0.20299 | 9.188843 |
| 1.191498 | -0.14417 | 9.012314 |
| 0.554062 | -0.19319 | 8.914246 |
| 0.27948 | -0.13435 | 8.953476 |
| 0.269684 | -0.19319 | 8.904434 |
| 0.250061 | -0.15396 | 9.06134 |
| 0.230453 | -0.11473 | 8.982895 |
| 0.259872 | -0.12454 | 9.031921 |
| 0.230453 | -0.10493 | 8.982895 |
| 0.269669 | -0.16377 | 9.051544 |
| 0.269669 | -0.10493 | 9.071152 |
| 0.230453 | -0.15396 | 9.022125 |
| 0.269684 | -0.11473 | 9.041733 |
| 0.259872 | -0.13435 | 8.933853 |
| 0.24025 | -0.15396 | 8.9730835 |
| 0.259872 | -0.13435 | 8.982895 |
| 0.230438 | -0.15396 | 8.855408 |

Table 4 accelerometer y positive direction

|  |  |  |
| --- | --- | --- |
| X-axis | Y-axis | Z-axis |
| 0.102966 | -0.24222 | 8.933868 |
| 0.27948 | -0.31087 | 8.933853 |
| 0.112778 | -0.32068 | 8.875031 |
| 0.161804 | -0.22261 | 8.982895 |
| 0.299088 | -0.24222 | 8.8358 |
| 0.201019 | -0.18338 | 8.669083 |
| 0.044128 | -0.18338 | 8.816177 |
| -0.22066 | -0.23242 | 9.071152 |
| -0.09317 | -0.19319 | 8.767151 |
| 0.102966 | -0.30107 | 8.973084 |
| -0.06375 | -0.27164 | 9.012314 |
| 0.004898 | -0.29126 | 8.992706 |
| 0.122574 | -0.37952 | 9.041733 |
| 0.05394 | -0.28145 | 9.100571 |
| -0.0049 | -0.31087 | 9.100571 |
| 0.044128 | -0.36971 | 9.100571 |
| 0.083359 | -0.35989 | 9.031937 |
| 0.024521 | -0.26184 | 8.8358 |
| -0.11278 | -0.40894 | 8.933868 |
| -0.2991 | -0.31087 | 8.747543 |
| 0.161804 | 0.52269 | 8.973084 |
| 1.681824 | 0.973801 | 10.64021 |
| -0.82866 | -1.49748 | 5.138687 |
| -2.00546 | -2.15451 | 7.100021 |
| -1.09344 | -1.19347 | 8.68869 |
| -0.50505 | -0.40894 | 8.737732 |
| -0.24026 | -0.12454 | 8.79657 |
| 0.05394 | -0.13435 | 8.825989 |

Table 5 accelerometer y negative direction

|  |  |  |
| --- | --- | --- |
| X-axis | Y-axis | Z-axis |
| 0.308899 | 0.277527 | 8.894638 |
| 0.436386 | 0.218689 | 9.002502 |
| 0.465805 | 0.297134 | 8.943665 |
| 0.38736 | 0.346176 | 8.924057 |
| 0.367737 | 0.228485 | 9.080963 |
| 0.465805 | 0.071579 | 9.434006 |
| 0.338318 | 0.189255 | 9.54187 |
| 0.446182 | 0.100998 | 9.237869 |
| 0.534454 | -1.46805 | 9.473221 |
| 1.368012 | -5.16516 | 8.933868 |
| 1.162079 | -0.76198 | 7.60997 |
| 2.083908 | 2.317307 | 9.757614 |
| 0.671753 | 0.061768 | 9.610519 |
| -0.45601 | -0.30106 | 8.79657 |
| -0.38736 | -0.60507 | 8.79657 |

Table 6 accelerometer z positive direction

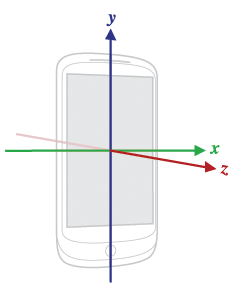
|  |  |  |
| --- | --- | --- |
| X-axis | Y-axis | Z-axis |
| 0.299088 | -0.2128 | 9.218262 |
| 0.338318 | -0.22261 | 9.06134 |
| 0.416779 | -0.24222 | 9.012314 |
| 0.348129 | -0.22261 | 9.031937 |
| 0.27948 | -0.17358 | 9.002518 |
| 0.299103 | -0.19319 | 8.992706 |
| 0.328522 | -0.2128 | 9.022125 |
| 0.338318 | -0.18338 | 8.982895 |
| 0.397156 | -0.23242 | 8.933853 |
| 0.338318 | -0.19319 | 8.982895 |
| 0.31871 | -0.2128 | 8.973084 |
| 0.299088 | -0.203 | 9.031921 |
| 0.328506 | -0.19319 | 9.061356 |
| 0.357941 | -0.19319 | 9.012314 |
| 0.377548 | -0.21281 | 9.031921 |
| 0.348129 | -0.22261 | 8.943665 |
| 0.328522 | -0.19319 | 9.012314 |
| 0.328506 | -0.17358 | 9.041733 |
| 0.328506 | -0.17357 | 8.982895 |
| 0.367737 | -0.22261 | 8.963272 |
| 0.38736 | -0.23242 | 9.041733 |
| 0.367737 | -0.31087 | 9.022125 |
| 0.367737 | -0.28145 | 8.982895 |
| 0.367737 | -0.24223 | 8.943665 |
| 0.406967 | -0.24222 | 8.953476 |
| 0.416779 | -0.26184 | 8.992706 |
| 0.357925 | -0.203 | 9.051544 |
| 0.348129 | -0.21281 | 8.933868 |
| 0.387344 | -0.22261 | 9.012314 |
| 0.357925 | -0.24223 | 8.963287 |
| 0.308899 | -0.24222 | 12.5231 |
| 0.328506 | -2.32123 | 11.09132 |
| -0.34814 | -0.3501 | 4.11879 |
| -0.86789 | 2.199631 | 5.90361 |
| -0.76982 | 2.807632 | 8.669083 |
| 0.014709 | 2.278076 | 9.257477 |
| 0.083359 | 1.522965 | 9.237869 |
| -0.79924 | 1.787735 | 9.061356 |
| -1.12286 | 1.699478 | 8.816177 |
| -1.34842 | 1.876007 | 8.776962 |
| -1.34842 | 2.150589 | 8.512177 |

Table 7 accelerometer z negative direction

|  |  |  |
| --- | --- | --- |
| X-axis | Y-axis | Z-axis |
| -0.10297 | 0.454041 | 8.933853 |
| 0.102966 | 0.297134 | 9.179031 |
| 0.151993 | 0.199066 | 9.149612 |
| 0.210831 | 0.199066 | 9.080963 |
| 0.05394 | 0.287323 | 8.982895 |
| 0.004898 | 0.306946 | 9.071152 |
| 0.112762 | 0.297134 | 9.071152 |
| -0.0049 | 0.552109 | 8.27681 |
| -0.0049 | 0.405014 | 4.216858 |
| 2.005447 | 0.277512 | 5.540756 |
| 2.162354 | -0.41875 | 11.07172 |
| -0.68156 | -0.66391 | 9.532074 |
| -1.54456 | -0.54623 | 8.884827 |
| -0.70117 | -0.203 | 8.894638 |
| 0.161804 | -0.07552 | 8.904434 |
| 0.27948 | -0.09512 | 8.914246 |
| 0.308899 | -0.15396 | 8.963287 |
| 0.348129 | -0.12454 | 8.992706 |

**Discussion**

1. From the graph and data, we obtained can understand the orientation of phone from the direction of the gravity.



1. The noise of the device also effecting the reading. From the stationary data we can understand the object is constantly accelerating. This maybe due to we have 1 degree slanted from gravitational force.
2. To measure distance from the data is impossible because the data is inconsistent. To obtain distance from acceleration. It will be a double integration which . The reading will drift dynamically.
3. Forward and backward direction of movement acceleration graph have two different pattern. Forward direction form a positive peak then negative peak while backward direction will negative peak then positive peak.
4. From the documentation of the android development [2]. The unit measurement of this is m/s. From stationary data in table 1, it constantly drifts 0.2 m/s the drifting is too large until the point that we unable to calculate distance travel.
5. From the reading, we also understand accelerometer is very sensitive toward orientation of the phone. Slightly slanted will affect all the value change in unpredictable way.

**Conclusion**

1. Rawdata is good in interpret orientation of phone but not in measuring distance
2. Accelerometer can use to determine the direction moved but not the distance move.

**Experiment 2 linear acceleration**

From pervious experiment, we understand gravity give a great impact on distance measurement. To isolate gravity acceleration, we used low pass filter. Same procedure repeated to produce the same data.

**Result**

Table 1 stationary phone

|  |  |  |
| --- | --- | --- |
| X-axis | Y-axis | Z-axis |
| 0.250061 | -0.09512 | 8.973084 |
| 0.250061 | -0.09512 | 8.973084 |
| 0.084989 | -0.03972 | 3.944622 |
| 0.075841 | -3.96E-04 | 3.155698 |
| 0.013602 | -0.0317 | 2.493174 |
| 0.026568 | -0.00183 | 2.025924 |
| 0.036953 | -0.0093 | 1.573669 |
| -0.00182 | -0.02314 | 1.211865 |
| -0.04854 | -0.02635 | 1.008713 |
| -0.00744 | -0.02109 | 0.822668 |
| 0.025423 | -0.00902 | 0.650286 |
| 0.028188 | -0.00722 | 0.575135 |
| -0.01667 | -0.00577 | 0.460108 |
| 0.025884 | -0.02031 | 0.328865 |
| 0.020708 | -0.04763 | 0.294477 |
| 0.008717 | 0.001131 | 0.227732 |
| 0.006974 | 8.92E-04 | 0.11943 |
| 0.029114 | 7.26E-04 | 0.158299 |
| 0.038977 | -0.00727 | 0.142325 |
| -1.90E-04 | -0.00581 | 0.11386 |
| 0.007697 | 0.011034 | 0.091101 |
| -0.03308 | -0.01471 | 0.096416 |
| -0.02646 | 0.003932 | 0.061434 |
| -0.03685 | -0.0047 | 0.033461 |
| 0.009738 | 0.035458 | 0.01107 |
| -0.01575 | -0.01085 | 0.024554 |
| -0.0126 | -8.34E-04 | -0.03528 |
| -0.01008 | 0.007169 | -0.04391 |
| 0.015474 | 0.005735 | -0.04297 |
| 0.00453 | 0.020287 | -0.02653 |
| 0.019322 | 0.039764 | -0.00554 |
| 0.023307 | 0.039648 | 0.04264 |
| -0.0049 | -0.03104 | 0.018426 |
| 0.058847 | -0.00129 | 0.006891 |
| 0.031379 | 0.006813 | -0.03371 |
| 0.025103 | -0.0024 | 0.020104 |
| -0.03482 | -0.0176 | 3.98E-04 |
| -0.02002 | 0.017288 | -0.03107 |
| -0.00817 | -0.0097 | 0.030054 |
| 0.001314 | 0.015771 | 0.031892 |
| 0.001051 | -0.01092 | 0.064747 |
| -0.00701 | -0.04012 | 0.012564 |
| -0.01344 | 0.007138 | 0.033587 |
| 0.028466 | 0.076316 | 0.01902 |
| 0.007087 | 0.053204 | -0.024 |
| -0.01003 | -0.00451 | -0.03489 |
| -1.74E-04 | -0.03499 | 0.00346 |
| 0.015547 | -0.03583 | 0.002768 |
| 0.012438 | -0.03651 | -0.02916 |
| -0.00574 | -0.03706 | -0.02333 |
| -0.01244 | -0.02965 | -0.00297 |
| 0.005736 | -0.03155 | -0.02591 |
| -0.01893 | -0.00956 | -0.02073 |
| 0.016225 | 0.031575 | 0.00695 |
| 0.028666 | 0.025272 | 0.00556 |
| -0.01629 | -0.00333 | -0.0034 |
| 0.002655 | -0.0262 | -0.02626 |
| 0.002124 | -0.01311 | 0.026066 |
| -0.02184 | 0.020896 | -0.00267 |
| -0.03315 | -0.00682 | -0.04137 |
| -0.01867 | -0.0133 | 0.053196 |
| 0.047817 | -0.00279 | 0.003336 |
| 0.014718 | -0.03362 | -0.01302 |
| -0.0353 | -0.01121 | -0.01826 |
| -0.0047 | 0.022417 | 0.024611 |
| -0.0273 | 0.010097 | -0.04307 |
| 0.009547 | -0.00762 | 0.036151 |
| 0.007638 | 0.033124 | 0.052456 |
| -0.00959 | 0.042198 | 0.0655 |
| -0.00767 | 0.025909 | 0.036715 |
| 0.009562 | 0.005041 | -0.00201 |
| 0.00765 | -0.0352 | -0.03299 |
| 0.061027 | -0.01246 | -0.03423 |

Table 2 move in x positive direction

|  |  |  |
| --- | --- | --- |
| X-axis | Y-axis | Z-axis |
| 0.051008 | -0.01937 | 0.0952 |
| 0.001573 | 0.015888 | 0.02124 |
| -0.04581 | -0.00299 | -0.06146 |
| 0.002584 | 0.005459 | -0.04917 |
| -0.0607 | 0.035739 | -0.07856 |
| -0.04071 | 0.005068 | -0.02361 |
| 0.006652 | 0.011891 | -0.03459 |
| -0.01036 | 0.009513 | -0.05121 |
| 0.658554 | -0.15714 | -0.03312 |
| 1.80564 | -0.15709 | -0.05788 |
| -1.2935 | -1.49E-04 | -0.08552 |
| -2.60387 | -0.33747 | -1.39429 |
| -0.25513 | 0.169365 | -0.03277 |
| 0.297985 | 0.206097 | 0.256215 |
| 0.285458 | 0.227634 | 0.330497 |
| 0.283286 | 0.205655 | 0.287932 |
| 0.163872 | 0.140976 | 0.191125 |

Table 3 move in x negative direction

|  |  |  |
| --- | --- | --- |
| X-axis | Y-axis | Z-axis |
| 5.26E-04 | 0.050142 | -0.04293 |
| -0.0388 | -0.01479 | -0.06571 |
| 3.44E-04 | -0.004 | 0.002336 |
| 0.02381 | -0.03457 | -0.01382 |
| 0.00335 | 0.042949 | 0.028167 |
| 0.00268 | 0.02651 | -0.04022 |
| -0.00569 | 0.021208 | 0.03059 |
| -0.00455 | -0.06933 | -0.05398 |
| -0.01149 | -0.00839 | 0.011733 |
| -0.00919 | -0.05378 | -0.04553 |
| 4.94E-04 | -0.0195 | 0.010644 |
| -0.03884 | -0.03913 | 0.016352 |
| -0.00754 | -0.00776 | 0.052315 |
| -1.96736 | -0.09252 | 0.041852 |
| -1.11886 | -0.25446 | 0.04133 |
| 2.925594 | -0.43108 | -0.10031 |
| 1.077365 | -0.10165 | -0.0724 |
| 0.132278 | 0.036355 | 0.012687 |
| -0.10599 | 0.036933 | -0.01339 |
| -0.14756 | -0.01752 | -0.00286 |
| -0.1102 | -0.05325 | 0.013399 |
| -0.07248 | -0.00337 | -0.02067 |
| -0.04228 | -0.01839 | -0.02438 |
| -0.04952 | 9.84E-04 | -0.02734 |
| -0.07099 | -0.00706 | -0.01402 |
| -0.00972 | 0.033584 | -0.00338 |

Table 4 move in y positive direction

|  |  |  |
| --- | --- | --- |
| X-axis | Y-axis | Z-axis |
| 0.005362 | 0.023939 | -0.04018 |
| 0.019976 | 0.003453 | 0.030611 |
| 0.031679 | -0.02862 | 0.01664 |
| -0.00604 | -0.04642 | -0.02591 |
| -0.00483 | -0.0293 | -0.02858 |
| -0.0431 | 9.55E-05 | -0.01501 |
| 0.02044 | 0.015775 | 0.003688 |
| 0.008503 | -0.00308 | -0.0206 |
| -0.00888 | -0.03383 | 0.007058 |
| -0.00711 | 0.012153 | 0.005647 |
| 0.025699 | 0.833478 | -0.02685 |
| 0.004873 | 1.247324 | 0.190333 |
| -0.06672 | -0.28876 | -2.2484 |
| -0.11613 | -0.59189 | -0.12767 |
| -0.17921 | -0.18324 | 0.28229 |
| -0.1669 | -0.11521 | 0.319973 |
| -0.10214 | -0.10786 | 0.295212 |
| -0.08956 | -0.08629 | 0.251856 |
|  |  |  |

Table 5 move in y negative direction

|  |  |  |
| --- | --- | --- |
| X-axis | Y-axis | Z-axis |
| 0.009687 | -0.01925 | -0.04518 |
| -0.00795 | -0.05463 | 0.003092 |
| 0.009339 | -0.03586 | 0.025996 |
| -3.78E-04 | 0.018385 | -0.03411 |
| -0.03167 | -0.00883 | -0.01945 |
| 0.021719 | 0.024322 | 0.007975 |
| 0.001689 | 0.027295 | 0.045613 |
| 0.001351 | -0.01739 | 0.052176 |
| -0.02245 | 0.033162 | 0.010357 |
| -0.0415 | 0.02653 | 0.03967 |
| -0.00966 | 0.013375 | -0.05456 |
| -0.00773 | -0.01284 | -0.01226 |
| -0.00618 | 0.013267 | -0.00982 |
| -0.02848 | 0.010613 | -0.08631 |
| 0.008598 | 0.01634 | -0.0612 |
| 0.030413 | -0.01831 | 0.021658 |
| 0.040017 | 0.001036 | 0.017326 |
| 0.008478 | 0.008678 | 0.092303 |
| -0.11089 | -2.00146 | -0.13797 |
| 0.170172 | -1.60116 | -0.20453 |
| 0.426421 | 1.527686 | -0.10871 |
| 0.090087 | 1.990985 | 0.038561 |
| 0.087756 | 0.384621 | 0.038698 |
| 0.09374 | 0.040949 | 0.038808 |
| 0.051457 | -0.11629 | 0.085966 |
| 0.07255 | -0.07734 | -0.00183 |
| 0.034504 | -0.03834 | 0.053441 |
| 0.035453 | -0.00714 | 0.034904 |

Table 6 move in z positive direction

|  |  |  |
| --- | --- | --- |
| X-axis | Y-axis | Z-axis |
| 0.055925 | -0.10073 | 0.24668 |
| -0.01017 | -0.03353 | 0.197344 |
| -0.01598 | 0.114402 | -0.05394 |
| -0.01279 | 0.052288 | -0.051 |
| 0.076062 | 0.010459 | -0.11926 |
| 0.037315 | -0.04655 | -0.0091 |
| -0.02506 | -0.07648 | -0.01513 |
| 0.019177 | 0.001588 | -0.04349 |
| 0.070261 | -0.00658 | -0.05048 |
| 0.04836 | 0.018285 | -0.07177 |
| 0.109293 | -0.47179 | 1.119381 |
| -0.06947 | -0.33036 | 1.962473 |
| -0.01635 | 0.002449 | -0.00694 |
| 0.09675 | 0.676654 | -1.62169 |
| -0.00104 | 1.098342 | -1.80729 |
| 0.038387 | 1.239563 | -1.02218 |
| -0.14972 | 0.583691 | -0.20581 |
| -0.7474 | 0.663083 | 0.078554 |
| -0.69206 | 0.554002 | 0.384499 |
| 0.113196 | 0.443201 | -0.13958 |
| -1.32944 | 0.354561 | 0.060929 |
| -0.34179 | 0.503327 | 0.284107 |
| 0.032541 | -0.44464 | 0.038992 |
| 0.065254 | -0.40278 | 0.141032 |

Table 7 move in z negative direction

|  |  |  |
| --- | --- | --- |
| X-axis | Y-axis | Z-axis |
| 0.096362 | 0.230714 | -0.88098 |
| 0.053555 | 0.239491 | -0.42235 |
| 0.019309 | 0.19158 | 0.132833 |
| 0.070366 | 0.137578 | 0.365165 |
| 0.103363 | 0.172831 | 0.135222 |
| 0.098377 | 0.106881 | 0.170935 |
| 0.133621 | 0.148261 | -0.26335 |
| -0.04216 | 0.165679 | -1.45026 |
| -0.324 | -0.07927 | -1.60737 |
| 0.03107 | -1.64816 | -0.90932 |
| -0.50078 | -2.02462 | 3.289338 |
| 0.376049 | -2.37284 | 2.513795 |
| 1.006918 | -0.81562 | 0.449818 |
| 0.326982 | 0.539995 | -0.24424 |
| 0.347877 | 0.447694 | -0.27384 |
| 0.348907 | 0.475819 | -0.14062 |

Table 8 accumulate distance

|  |  |  |
| --- | --- | --- |
| X-axis | Y-axis | Z-axis |
| 0.014171 | -0.0457 | 2.676527 |
| 0.027787 | -0.08979 | 5.240583 |
| 0.040034 | -0.13628 | 7.876968 |
| 0.050844 | -0.1831 | 10.50711 |
| 0.061666 | -0.22956 | 13.14047 |
| 0.072658 | -0.27511 | 15.77403 |
| 0.083522 | -0.31951 | 18.41806 |
| 0.093711 | -0.36291 | 21.04468 |
| 0.103451 | -0.40638 | 23.68076 |
| 0.112429 | -0.44951 | 26.30179 |
| 0.120399 | -0.49341 | 28.93341 |
| 0.128758 | -0.53784 | 31.54994 |
| 0.13762 | -0.58256 | 34.16505 |
| 0.145972 | -0.62757 | 36.7918 |
| 0.153722 | -0.67279 | 39.41757 |
| 0.16139 | -0.71821 | 42.0154 |
| 0.169609 | -0.76491 | 44.64206 |
| 0.178212 | -0.81245 | 47.26324 |
| 0.186758 | -0.8601 | 49.87462 |
| 0.195135 | -0.90818 | 52.48613 |
| 0.203576 | -0.95717 | 55.11117 |
| 0.211875 | -1.00526 | 57.73713 |
| 0.220765 | -1.05184 | 60.33683 |
| 0.231245 | -1.09868 | 62.96445 |
| 0.242555 | -1.14467 | 65.58022 |
| 0.25431 | -1.1899 | 68.20903 |
| 0.265366 | -1.23395 | 70.82549 |
| 0.275002 | -1.27763 | 73.45586 |
| 0.284367 | -1.32189 | 76.09913 |
| 0.294398 | -1.36828 | 78.72804 |
| 0.304556 | -1.41517 | 81.34249 |
| 0.314747 | -1.46209 | 83.9682 |
| 0.32424 | -1.50845 | 86.42974 |
| 0.333848 | -1.55375 | 89.04305 |
| 0.344713 | -1.59827 | 91.67046 |
| 0.35633 | -1.64256 | 94.28296 |
| 0.367638 | -1.68717 | 96.8934 |
| 0.378116 | -1.73208 | 99.521 |

Discussion

1. From the graph 1, the gravity acceleration is eliminated and reduce to near to zero, however the reading is still very high. Since the reading is in m/s. average it drifts 0-25 cm per second which is very large for our measurement.
2. From the linear acceleration graph shown at above the reading have been filter and stability have increase but still cannot use to measure distance travel by the phone.
3. From the pattern of the graph we can determine the direction of motion but cannot measure the distance travel.
4. The formula applied to calculate velocity is and the formula for distance is
5. Conceptually velocity is single integration and distance is double integration of acceleration. In another word we are single and double integration of noise as well. At the end the data is not accuracy and with many errors.

Conclusion

Accelerometer is helpful in orientation application but not in distance measurement application.

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