Calculating ground shear strain (GSS) of microtremor data using graphical user interface python programming

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Abstract. Programming was made to calculate the Ground Shear Strain (GSS) value of microtremor data using Python. Microtremor is a repetitive ground vibration that propagates in soils containing certain sources. The microtremor method can be used to determine the value of Ground Shear Strains (GSS). Ground Shear Strain can be used to characterize the impacts occur during earthquakes, such as liquefaction, soil cracking, land subsidence, landslides, and ground vibration. Analyzing GSS value can be used to obtain information about soil response of an earthquake as a disaster reconstruction in the mitigation effort. In this research, the data processing conducted by the following steps: (i) Processing data using geopsy software to get the values of predominant frequency ($f_0$) and amplification($A_0$), (ii) Finding $v_s30$ value using USGS data, and (iii) Making python scripts for calculating microtremor data. The result of this research showed that calculating microtremor data can be done by using python software and has the same value as if using Microsoft excel.

1. Introduction
Ground Shear Strain (GSS) is the ability of the soil layer to stretch and shift when an earthquake occurs. GSS can be used to characterize the impacts that occur during earthquakes, such as liquefaction, soil cracking, land subsidence, landslides, and ground vibration. By analyzing the value of GSS, it can be used to obtain information about soil response of an earthquake as a disaster reconstruction in the mitigation effort. Earthquake disaster mitigation includes the concept of modeling and initial plans for earthquake disaster risk mitigation [1].

Seismic methods can be used to determine structural models of the subsurface in a wide area, but exploration using seismic methods is still difficult economically and technically, especially in urban areas. Observations using the microtremor method can be done to assess the effects of soil conditions in earthquake engineering [2]. Exploration using microtremor is considered cheaper and more effective. Microtremor is a constant vibration on the ground with a certain amplitude and can describe the geological conditions of the region due to natural or artificial events, such as wind, sea waves or vehicle vibrations [3]. The measured microtremor data can then be used to determine the Ground Shear Strain (GSS) value based on the predominant period parameters and the amplification factor [4].

This study aims to make microtremor data calculation programming to calculate the Ground Shear Strain (GSS) value using Python software so that it is more efficient in data processing which can later be used to map earthquake-prone areas. Python itself is a multiplatform programming language that offers...
various facilities in writing a program and can run in environments such as Windows, Linux, UNIX, and Mac. Python is in great demand because of its simplicity. Python is also easy for anyone to read and easy to learn by both beginners and programmers. Python supports the concept of reusability, which is the ability to develop code against the available code [5].

2. Methods
The equipment used in this research consisted of tools and materials. The tools consisted of 1) python software to make the numerical calculation and contour map, 2) sessarray geopsy that functions to process microtremor raw data and produce parameters predominant frequency and amplification, 3) Microsoft excel that function to calculate GSS value, 4) surfer 11 that function to make contour maps. The display design of the data processing program is shown in Figure 1.

![Figure 1](image.png)

Figure 1. The display design of the data processing program

While the materials used in this research consisted of 1) secondary data from microtremor acquisition conducted at Diponegoro University, 2) Yogyakarta earthquake data in 2006 and 3) additional data from the United States Geology Survey (USGS) of Vs30 data or shear wave velocity at 30 meters depth each point. The data used in this research were point UN1, UN2, UN 3, UN4, UN5, UN6, UN7, UN8, UN9, UN10, UN11, UN12, UN14, UN14, UN16, UN17, UN18, UN21, UN21, UN22, and UN24. Each point takes 10 minutes acquisition.

3. Results and discussions
Programming was made for calculating Ground Shear Strain (GSS) values using Python software. The data used are secondary data obtained from microtremor acquisition at Diponegoro University, Yogyakarta earthquake data in 2006 and additional data from the United States Geology Survey (USGS) of Vs30 data or shear wave velocity at a depth of 30 meters at the research point.

The results of calculating Peak Ground Acceleration (PGA) values using Microsoft Excel and Python software are shown in Table 1.

| No | Point | PGA using excel | PGA using Python |
|----|-------|----------------|-----------------|
| 1  | UN 1  | 2,45           | 2,45            |
| 2  | UN 2  | 2,92           | 2,92            |
| 3  | UN 3  | 2,005          | 2,005           |
Data calculated using Microsoft Excel shows the PGA values along with the measurement points ranging from (1.85 - 14.77) while data calculated using Python software shows PGA values ranging between (1.85 - 14.77). This shows that the PGA value along the measurement point when calculated either manually or using Python software is the same value. From the calculation data, it can be seen that the largest PGA value is obtained at point UN 14 which is 14.77 while the lowest PGA value is obtained at point UN 6 which is 1.85.

The magnitude of the PGA value is influenced by several factors including the coordinates of the measurement point, earthquake magnitude, hypocenter distance, depth of the earthquake source, and predominant period values. The greater the PGA value, the ground movement in the event of an earthquake will be faster and vice versa, the smaller the PGA value, the ground movement in the event of an earthquake will be slower.

Table 2 showed the results of calculating the value of the Seismic Vulnerability Index (Kg) using Microsoft Excel and Python software.

| No | Point | Kg value using excel | Kg value using python |
|----|-------|----------------------|----------------------|
| 1  | UN 1  | 0.0725               | 0.0725               |
| 2  | UN 2  | 0.0352               | 0.0352               |
| 3  | UN 3  | 0.241                | 0.241                |
| 4  | UN 4  | 0.205                | 0.205                |
| 5  | UN 5  | 0.000281             | 0.000281             |
| 6  | UN 6  | 0.321                | 0.321                |
| 7  | UN 7  | 0.281                | 0.281                |
| 8  | UN 8  | 0.0261               | 0.0261               |
| 9  | UN 9  | 0.134                | 0.134                |
| 10 | UN 10 | 8.31E-05             | 8.31E-05             |
| 11 | UN 11 | 0.0793               | 0.0793               |
| 12 | UN 12 | 0.0898               | 0.0898               |
| 13 | UN 14 | 0.179                | 0.179                |
| 14 | UN 16 | 0.000109             | 0.000109             |
| 15 | UN 17 | 0.161                | 0.161                |
| 16 | UN 18 | 0.215                | 0.215                |
The result of manually calculating Kg values using Excel shows the seismic vulnerability index values along with the measurement points ranging between. Likewise, with the results of calculations using Python software, the seismic vulnerability index values ranged between. The value of the largest seismic vulnerability index 0.321 at point UN 6 while the value of the smallest seismic vulnerability index $8.31 \times 10^{-3}$ at point UN 10.

The value of the seismic vulnerability index is influenced by several factors, including the value of the amplification factor (A), the predominant frequency, and the value of the wave velocity on the surface. The seismic vulnerability index shows the stability of the soil structure. The greater the seismic vulnerability index, the stability of the soil structure will be smaller so that the soil will be easily damaged if an earthquake occurs.

Table 3 showed the results of calculating the Ground Shear Strain (GSS) value using Microsoft Excel and Python software.

| No | Point | GSS value using Excel | GSS value using Python |
|----|-------|-----------------------|------------------------|
| 1  | UN 1  | 0.00178               | 0.00178                |
| 2  | UN 2  | 0.00103               | 0.00103                |
| 3  | UN 3  | 0.00483               | 0.00483                |
| 4  | UN 4  | 0.00505               | 0.00505                |
| 5  | UN 5  | 2.39E-05              | 2.39E-05               |
| 6  | UN 6  | 0.00595               | 0.00595                |
| 7  | UN 7  | 0.00526               | 0.00526                |
| 8  | UN 8  | 0.000839              | 0.000839               |
| 9  | UN 9  | 0.00304               | 0.00304                |
| 10 | UN 10 | 1.12E-05              | 1.12E-05               |
| 11 | UN 11 | 0.00208               | 0.00208                |
| 12 | UN 12 | 0.00208               | 0.00208                |
| 13 | UN 14 | 0.00467               | 0.00467                |
| 14 | UN 16 | 1.6E-05               | 1.6E-05                |
| 15 | UN 17 | 0.00379               | 0.00379                |
| 16 | UN 18 | 0.00479               | 0.00479                |
| 17 | UN 20 | 4.12E-05              | 4.12E-05               |
| 18 | UN 21 | 0.00289               | 0.00289                |
| 19 | UN 22 | 0.00152               | 0.00152                |
| 20 | UN 24 | 0.00181               | 0.00181                |

From the calculation results manually using Excel, the Ground Shear Strain (GSS) values obtained along the research point ranged between $(1.12 \times 10^{-5} - 5.95 \times 10^{-3})$. Similarly, the results obtained using Python software, the value of Ground Shear Strain (GSS) ranges between $(1.12 \times 10^{-5} - 5.95 \times 10^{-3})$. The minimum GSS value is obtained at the UN 10 point while the maximum GSS value is obtained at UN 6. The results of the calculation of the Ground Shear Strain (GSS) that have been carried out are then mapped to determine the distribution of Ground Shear Strain (GSS) values at Diponegoro University. The profile profile of the Ground Shear Strain (GSS) distribution using Python and Surfer is shown in Figure 2 and Figure 3, respectively.
Figure 2. Contour map using python

Figure 2 is the result of making a contour map using the python program. Figure 2 showed GSS values greater than 0.005 are marked in red and GSS values smaller than 0.001 are marked in purple.

Figure 3. Contour map using surfer 11

Figure 3 is the result of making a contour plot using surfer 11. Figure 3 showed GSS value greater than 0.006 is marked in blue and a GSS value less than 0.0004 is marked in light green.

The value of the Ground Shear Strain (GSS) in a surface layer can be obtained by multiplying the seismic vulnerability index (Kg) with the Peak Ground Acceleration (PGA). Nakamura (2000) revealed that the Ground Shear Strain (GSS) value indicates the ability of soil material to stretch or shift due to an earthquake. The deformation of the soil layer depends on the condition of the local geological layer in an area. The higher the Ground Shear Strain (GSS) value, the soil layer will be easier to undergo deformation on the contrary the smaller Ground Shear Strain (GSS) value indicates that the soil layer is sturdy and difficult to deform. Based on the calculation of Ground Shear Strain (GSS) values along with the research point, the Diponegoro University Ground Shear Strain (GSS) values ranged from $1.12 \times 10^{-5}$ to $5.95 \times 10^{-3}$.
4. Conclusion

The design of integrated polarizer tools can be used to evaluate the quality of cooking oil based on the Microtremor data processing to calculate the value of Ground Shear Strains (GSS) can be done using Python software. The value of Ground Shear Strain (GSS) along the point of acquisition ranged from \((1.12 \times 10^{-5})\) to \((5.95 \times 10^{-3})\). From the result obtained that the value of Ground Shear Strain (GSS) microtremor data processing with Python software is not much different from the processing done manually using Microsoft Excel.

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