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論 文 要 旨

THESIS SUMMARY

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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words）

In the field of impact engineering, impact force is one of the most concerning issues because it is the main cause of structural damage. Understanding the history of impact force applied on structures is crucial to study the impact behavior or performances of structure during impact event. As well known, impact force is almost impossible to measure directly in practice. Instead, impact force is measured indirectly from its corresponding responses such as strain, displacement, or acceleration, etc. by means of deconvolution technique. Yet, reconstruction of impact force often faces many difficulties due to the ill-posed nature of deconvolution problem. Therefore, seeking a technique that is robust enough to accurately reconstruct impact force is still in demand. This research is concerned with a deconvolution technique using wavelet approach as an advanced technique for reconstructing impact force.

In Chapter 1, the difficulties and challenges involved in the field of impact force reconstruction, as well as the motivation of this research, are presented based on the review of related literature. Especially, some previous works which considered wavelets (or similar to the use of wavelets) for impact force reconstruction are reviewed in detail so that it could highlight the novelty and objectives of this study.

In Chapter 2, the establishment of deconvolution technique with the use of wavelets for reconstructing impact force is formulated. As the remarkable capability of the present technique, the employment of different scales and shifts of wavelets in order to mitigate the ill-posed problem is concentrated and addressed. In addition, in the hope of having a robust and comprehensive deconvolution technique, some previous considerations or regularization methods such as the use of multiple responses, mutual deconvolution, or application of the Truncated Singular Value Decomposition (TSVD) are also incorporated and utilized in this wavelet deconvolution technique (WDT).

In Chapter 3, numerical verification of the present technique is carried out. The WDT is deployed to reconstruct the impact force introduced by impact buckling on the thin-walled column at different impact velocities. In particular, the numerical force and strain responses obtained at the velocity 6 m/s are used as the reference force and reference response to

reconstruct impact forces produced by other velocities 1, 2, 3, 4, and 5 m/s. The reconstruction of these forces is conducted in terms of without applying regularization, with application of the conventional regularization method TSVD, with consideration of different scales of wavelets, and with consideration of different shifts of wavelets. In addition, the proposed technique is also applied when using multiple responses and considering mutual deconvolution. By comparing with impact force obtained by FEM, the reconstructed results show that without applying regularization or with applying TSVD, the WDT and the conventional deconvolution technique turn out similar reconstruction. However, by considering larger scales, the WDT indeed shows its capability in well mitigating the ill-posed problem, and as such, provides more stable reconstruction. The consideration of the number of shifts at the optimal scales also helps to enhance the reconstruction by further suppressing the error amplification. As the consequence, the WDT has demonstrated its superiority in comparison with the conventional method when successfully reconstructing the impact force with higher accuracy and more stability.

Chapter 4 is the experimental verification. The WDT is applied to reconstruct impact force produced by the impact hammer and the rubber ball acting on the polycarbonate plate at different heights. Namely, when dropping the impact hammer at 100 mm height, the actual impact force measured by impact hammer and response measured by strain gauges are utilized as reference data in order to reconstruct impact forces caused by different heights of impact hammer and rubber ball (150, 200, 250, and 300 mm). Results first show the successful reconstruction by means of the WDT. Second, in the similar manner as Chapter 3, with the considerations of appropriate scales and shifts, the present technique provides a very good reconstruction with higher accuracy and more stability. The method to select the suitable scales or shifts in this research based on the compromise between solution norm and residual norm can effectively be used as a criterion for reconstructing process.

Chapter 5 is to give some general conclusions throughout this work. As the objectives of this study, the WDT has successfully been developed with the consideration of not only scales but also shifts of wavelets. With these considerations, the capability of the proposed technique in solving the ill-posed nature of deconvolution problem has indeed been achieved. Thus, it can provide a better and reliable reconstruction in comparison with other previous techniques. Besides, in order to spread out this research, some research topics are suggested and it can be a research proposal in the future.