



502/E1

### Identification of the shape of a drumhead by the sound it produces

D.S. Rodrigo, D.C.N. Perera,\* and A.A.P. Sachitra

*Department of Mathematics, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka*

Drums are the world's oldest and most widespread of musical instruments. At the beginning Mathematicians started to investigate questions such as, if two drums sound exactly the same, where they have identical fundamental frequencies as well as harmonics, then what geometric features do they have in common? Followed by this, the Polish Mathematician Mark Kac in 1966 first posed the question, 'Can one hear the shape of a drum?' which remained unanswered for about quarter century until Gordon, Webb and Wopert (1992) gave an example of two differently shaped drums that sounded exactly the same (*i.e.*, having identical frequency spectra) answering negative to Kac's question. Nevertheless if basic shapes (like rectangular and circular), are considered to be the drum membrane, ignoring the air column below, whether it is possible to distinguish them by observing their frequency and amplitude spectra addressed by solving the wave equation in this research. The wave equation in two dimensions was solved in rectangular Cartesian coordinates and cylindrical polar coordinates using the method of separation of variables. The frequency spectrum for both cases were determined through numerical implementation of discrete Fourier transforms using MATLAB software. Results of the study show that a circular drumhead and a rectangular drumhead have distinct frequency spectra when both of them are subjected to initial symmetrical disturbances and hence it is possible to distinguish them from the sound they produce. Nowadays the most widely used drumhead is the round shape and rectangular drumheads are rarely used. The reason behind this is the monotonous hollow sound produced by the latter and the good sound and melody produced by the former. The key aspect of conducting this research is to inspect the reasons as to how this happens.

Key Words: Discrete Fourier Transform, Frequency Spectra