



**INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI**  
**SHORT ABSTRACT OF THESIS**

Name of the Student : Viyazonuo Terhijja  
Roll Number : 156141013  
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Name of Thesis Supervisor(s) : Prof. Priyankoo Sarmah  
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**SHORT ABSTRACT**

This thesis provides a detailed acoustic phonetic analysis of the Angami language (also known as Tenyidie) speech sounds, a lesser-studied Tibeto-Burman language spoken in northeast India. Nine significant contributions are made in this thesis. The primary contribution of this thesis involves the development of a speech corpus, which is manually annotated and segmented, aimed at advancing research on the Angami language. The second contribution of the thesis is a detailed acoustic study of voice onset time (VOT) in Angami plosives. The third contribution of the thesis is the study of acoustic characteristics of voiced and voiceless nasals along with their effect on vowel nasality. Furthermore, a fine-grained study of voiceless nasals was performed using Nasometer II. The fourth contribution of the thesis is the acoustic characterization of affricates and fricatives in Angami, using features such as centre of gravity (CoG), central moment, intensity, and percentage of voicing. The fifth contribution of the thesis is the acoustic characterization of lateral and approximants in Angami using spectral features such as the first four formants, HNR, CoG, in- tensity, and percentage of voicing. The result showed a clear distinction between the voiced and voiceless laterals and approximants; the formants (F1-F4) further showed a clear pattern to differentiate the approximants based on PoA. The thesis's sixth contribution is an intricate examination of vowels. It utilizes the first three formant frequencies F1, F2, and F3 and the duration to analyze monophthongs. This study also employs features, such as, the Discrete Cosine Transforms (DCT) of F1 and F2 and duration to investigate the diphthongs. The findings clearly identified six dis- tinct monophthongs and two diphthongs in the language. The seventh contribution of the thesis addresses issues in Angami tones and studies acoustic characteristics of tones using  $F_0$  and duration. The results showed that Angami has four distinct level tones. The  $F_0$  of the tones T2 and T3 overlap, and the tones are statistically not significantly different in terms of  $F_0$  or durations. The study also investigates the interaction of tones with segments, such as tones interaction with consonants and tone interaction with vowels. The finding of VOT interactions with  $F_0$  shows that the extent of consonantal perturbation depended on the tonal categories. The correlation of vowel height and intrinsic  $F_0$  ( $IF_0$ ) was also explored. The findings show that in Angami, high vowels induce higher  $F_0$ , and low vowels induce  $F_0$  lowering. Additionally, Angami has bidirectional tonal co-articulation, showing both anticipatory and carryover effects. For its eighth contribution, this thesis delves deeper into the acoustic correlates and classification of tones. Using random forest (RF) to classify the five-tone categories resulted in an accuracy of 66.4%. Interestingly, combining T2 and T3 led to a significant increase in accuracy, reaching 80.8%. Among the various acoustic features studied, the most prominent correlates of tones in Angami were found to be  $F_0$  mean,  $F_0$  height,  $F_0$  max, and  $F_0$  min. The thesis's ninth contribution involves studying native speakers' perception of tones through two separate tests. The first test, using male and female stimuli, revealed higher accuracy in identifying the high (T1) and low (T5) tones than the intermediary tones (T2, T3, & T4). Confusion mainly emerged between

tones T2 and T3. In the second perception test with synthesized stimuli, findings indicated that the identification of tones relies on two primary cues:  $F_0$  height and duration. Lower tones (T5 and T4) were predominantly identified based on duration, while higher tones (T1 and T2) were identified with  $F_0$  height.

