Haroon Dawood, Rehan Shahid, Touqeer Ahmed

Intonation Patterns in Punjabi

Abstract: *Emotions influence a person's way of speaking, and it is possible to identify the emotional state of a speaker by merely listening to spoken utterances [1]. This paper aims at presenting a detailed analysis of intonation patterns of Punjabi regarding basic emotions (natural, happiness, sadness, anger). The pitch and average fundamental frequency of a sentence is highly variable due to different emotional states, these variations are observed and the generalized syllable pattern map for these sentences is presented in this paper.*

1. INTRODUCTION

Numerous investigations from the past 50 years have shown that naive listeners are generally able to determine the emotional content of utterances only by hearing the speech signal. This indicates that speech not only conveys the strictly linguistic contents of sentences but also the expression of attitude and emotion of the speaker. When we speak our voices are rising and falling continually; to speak everything on one level would be extremely boring. What we are doing is altering the pitch level of our utterance, a bit like a pianist running up and down the notes in a particular key [6]. This variation of pitch is referred to as pitch patterns or *intonation patterns.* Speakers use these intonation patterns to help them communicate their ideas or emotions. But the emotion expressed by the speaker is not only present in global prosodic properties of the utterances, such as pitch level and pitch range, but also in more local properties as represented in the intonation patterns.

2. LITERATURE REVIEW

It would require a huge amount of effort to go back and look for past studies on prosody or intonation, which have been increasing exponentially in number over the years. Such a historical overview is beyond the scope of this paper. But it would be worth mentioning the efforts made on the concepts underlying current theories on intonation.

Intonation conveys meanings that apply to phrase or utterances as a whole, such as sentence type or speech act, or focus and information structure. By this definition intonation excluded features of stress, assent, and tone that are determined in the lexicon, which serve to distinguish one word from another (Ladd, 1996, p.8).

(Crystal, 1969, p.196) proposed a parametric definition: "Intonation refers to a phenomenon which has a very clear center of pitch contrast, and a periphery of reinforcing and occasionally contradicting contrasts of different order."

Intonation patterns are specified as an abstract sequence of high and low tones. These tones have no absolute physical value. Rather, they are implemented relative to each other through the manipulation of pitch and the fundamental frequency (F_0) of the voice (Ladd 1996).

(Liberman 1975) pursued the same approach to characterize intonation more generally. For example, he identified a LHM "calling" intonation, in which the H tone characterizes the main stress, and the initial L tone spreads on to all pre-stress syllables.

(Pierrehumbert 1980) distinguished between different types of tonal targets and proposed to use H and L boundary tones at the beginning and end of major phrases, as well as a H or L phrase accent at the end of each intermediate phrase.

However no significant work has been done on analyzing the intonation patterns found in Punjabi.

In this article we distinguish *three* essentially different but intimately related phenomena: pitch, tone and stress.

2.1 Pitch

Pitch is a surface level phenomena closely correlated with instrumental measurements of fundamental frequency (F_0). It is directly observable and is essentially continuous. Tone and intonation are two important linguistic factors contributing to the surface realization of pitch [4].

2.2 Tone

Tone refers to a formal binary system auto-segmentally associated with syllable nuclei. Tone values in this sense participate in a tonal phonology, which permits deletion and re-association of tones. Tones do have an associated relative phonetic pitch, but tone values by themselves don't completely determine the surface pitch [4].

2.3 Stress

Stress is the relative prominence of syllables. Among the syllables of a word, one syllable usually stands out as more prominent than the other syllables. The stress position is determined by the structure of words and phrases in a sentence [6].

2.4 Intonation in Punjabi

Punjabi is a very rich language, originated in its true nature from the heart of the subcontinent. It is spoken and understood in many regions of different countries. Each language deals with expressing emotional ranges and contextual importance in different ways. Some languages, such as French, stress the end of a sentence, and then use word order to indicate an important change. Other languages, such as Chinese, have a pitch variation that

indicates different vocabulary words [13]. Punjabi language has a number of intonation patterns, which add conventionalized meanings to the utterance.

There is no real agreement amongst phonologists about the exact number of tones in speech, but all agree on at least four. These are:

1.Fall 3.Rise

2.Fall-Rise 4.Rise-fall

These tones are illustrated by the four intonational possibilities of the simple utterance *NO* informally described in the following example from English [6]:

NO: (definitely not)

NO: (are you sure?)

NO: (really? Is that so?)

NO: (stop that right now)

Traditionally, tone is linked with particular attitudes or emotions, as above. The most common are:

Falling tones: positive, or assertive attitude - /that's MINE/, /he is a FOOL/

Falling-rising: doubtful, uncertain attitude - /he COULD/, /I am not SURE/

Rising tones: enquiring, diffident attitude - /COFFee/

Rising-falling: impatient, sarcastic - /it's up to YOU/, /how NICE/

3 METHODOLOGY:

The framework adopted in the present study, is the model proposed by Pierrehumbert and Hirschberg (1990), which is known as the **PHH** model of intonation.

3.1 Theoretical Framework

The PHH model aims to codify the intonation patterns commonly used in interpersonal discourse. The model's units are the simplest possible code levels of relative pitch: High pitched peaks, H: low pitched regions, L: and combination of these events with stress (*) and end of utterance (%). At the same time the pitch patterns used must conform to the stress patterns of word and grammar.

Speakers compose tunes of voice pitches that are special intonation phrases that have boundary marks [7].

3.2 Data samples

The scope of the analysis was limited to these basic emotions: *natural*, *happiness*, *sadness*, and *anger*. Five sample sentences were used with four different emotions. These are presented below.

1. Ajj bazaar band ay (today, the market is closed).
2. Ae kora mera ay (this horse is mine).
3. Audi gaddi chut gaye (he missed his train).
4. Meri shadi ho rai ay (I am going to get married).
5. O sergi waylay aarea ay (he is coming early in the morning).

3.3 Speakers

Five male speakers were employed to speak every sentence *three* times that was block randomized with each of the *four* emotional contents, mentioned above. All the speakers had good Punjabi speaking abilities and all of them had Punjabi as their native language.

3.4 Experimental Analysis

All the recordings were done in the recording room of **C**enter for **R**esearch in **U**rdu **L**anguage **P**rocessing (CRULP).

The data recordings were then analyzed using PRAAT. The signals were modified by, inserting and deleting pitch points. Pitch points that occur due to the noise in the signal can be removed. This can be done by deleting the pitch point, and perceptually testing the sample, if the naturalness of the speech remains unaffected, then the pitch point is redundant and can be removed.

Acoustically F_0 transitions, values for low and high pitch points were recorded. The pitch point having a higher value with respect to the other pitch points in the manipulated sample is marked as 'H'. Similarly low pitch points are marked as 'L'. But if the difference of F_0 between two consecutive points is very small, then the succeeding point can be given the same pitch point mark as the preceding one. F_0 transition between two pitch points was calculated by subtracting the frequency of the respective pitch points. In addition to this the average F_0 value is also calculated for every signal. These values for different speakers can be seen in Appendix A.

4. RESULTS

We are considering only the 1st and the 5th sentence for the further interpretations and analyses.

4.1 Pattern of Fundamental Frequency

The data recorded shows that the trend for the natural utterance of the 1st sentence with stress on /bazar/ and /band/ varies between LH*L*HLHL% and LH*L*HLLL%. The first pattern LH*L*HLHL% occurs more frequently as compared to the second one. On the other hand the trend for the natural utterance of the 5th sentence with stress on /waylay/ and /aarea/ varies between HLHL*LL*% and HLHL*HL*%. The first pattern HLHL*LL*% occurs more frequently as compared to the second one.

The sequence for the happy utterance of the 1st sentence with stress on /band/ is LHLLH*L% for almost all the recordings. Similarly LHLHL*HL% trend was observed for same emotional utterance of the 5th sentence with stress on /aarea/.

The data recorded shows that the trend for the sad utterance of the 1st sentence with stress on /band/ varies

between HLLLL*L% and HLHLL*L%. The percentage of the first pattern is more than the other. While HL*HLHL% patterns was observed for the 5th sentence with stress on /sergi/.

For the angry utterance of the 1st sentence with stress on /band/, LLLHL*H% pattern was observed. While for the 5th sentence, with stress on /aarea/, LHLLH*H*L% pattern was observed most of the time.

4.2 F_0 Transitions

It is evident from the data given in Appendix B-1 that LH*L*HLHL% peaks for natural utterance of 1st sentence on average map at 139 Hz, 169 Hz, 137 Hz, 145 Hz, 130 Hz, 137 Hz and 112Hz respectively.
The snapshot of the modified signal for the natural utterance of 1st sentence is illustrated in Figure 1.

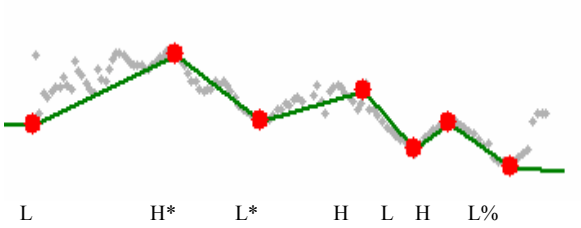

Figure 1

On average the LHLLH*L% peaks for speaker's happy utterance of first sentence map at 150 Hz, 214 Hz, 157 Hz, 158 Hz, 220 Hz and 172Hz respectively.
The snapshot of the modified signal for the happy utterance of the same sentence is illustrated in Figure 2.

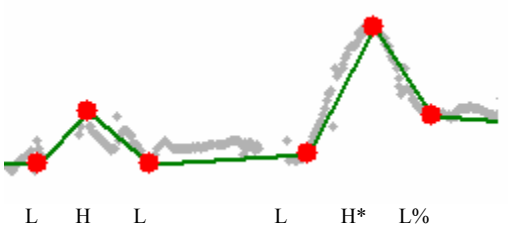

Figure 2

Similarly the HLLLL*L% peaks for speaker's sad utterance of first sentence takes values around 144 Hz, 127 Hz, 124 Hz, 120 Hz, 123 Hz, 130 Hz and 112 Hz respectively.

The snapshot of the modified signal for the sad utterance of 1st sentence is illustrated in Figure 3.

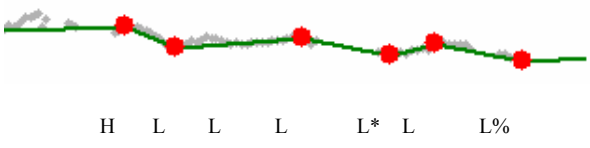

Figure 3

Finally the LHLHL*H% peaks for speaker's angry utterance of first sentence on average map around 158 Hz, 183 Hz, 151 Hz, 180 Hz, 140 Hz, 227 Hz and 158 Hz respectively.

The snapshot of the modified signal for the angry utterance of 1st sentence is illustrated in Figure 4.

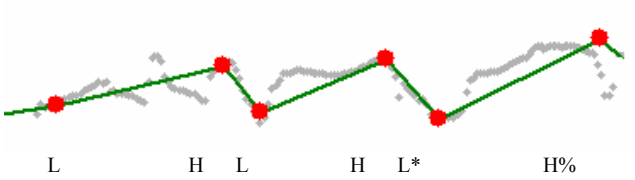

Figure 4

4.3 Average F_0

The values of the average F_0 for the 1st sentence can be described as follows: 138Hz for natural, 169Hz for happiness, 120 Hz for sadness and 172Hz for anger. The details are available in Appendix B-1.

The results for the 5th sentence can be found in Appendix B-2.

5. DISCUSSION

The results of this investigation show a number of specialties concerning the different emotions. Each measured item reveals particular characteristics of the emotions and makes it possible to distinguish between them.

5.1 Effect of F_0

Although the average F_0 varies with person to person, but if we use the average F_0 in the natural utterance as a point of reference, the results can be discussed as follows: more excited emotions (happiness and anger) were spoken with higher average F_0 then the natural statement, whereas the less excited emotion (sadness) was spoken with lower average F_0.

5.2 Syllable Patterns

The perception experiment confirmed that the intonation pattern is a relevant cue in signaling an emotion.

Although intonation patterns for a specific emotion change with respect to the sentence but there are some similarities that can be generalized on all the sentences. *Natural*: utterance in Punjabi shows a falling configuration at the edges of phrases, combined with at least two high pitch points (Figure 1). Its boundary tunes are also low. *Happiness* has a rising tone at the start and at the end it has a H*L pattern (Figure 2). *Sadness* has a rising tone at the start and then a sequence of low tones follows it (Figure 3). *Angry h*as a completely reverse pattern of sadness, it has trailing low tones and at the end it has a very high tone (Figure 4).

6. CONCLUSION

Although immense work has been done in the fields of intonation or prosody but efforts made in the direction of analyzing the intonation patterns in Punjabi are highly in sufficient. In this paper we have focused on

intonation patterns in Punjabi with respect to the basic emotions, and tried our best to give as few parameters as possible to completely realize an emotion. In the end we may conclude that the intonation pattern realized on an utterance is one of the key factors in determining the emotion conveyed in the speech. Particular patterns seem to be better suited for conveying some specific emotions and less suitable for others. Irrespective of the speaker, these patterns may form a general rule as discussed above. For instance, emotions with more excitement were spoken with higher average F_0 then the natural one, whereas the less excited emotion was spoken with lower average F_0. It has also been observed that all utterances are ended at low (L) tones except the angry, which is ended at high (H) pitch level.

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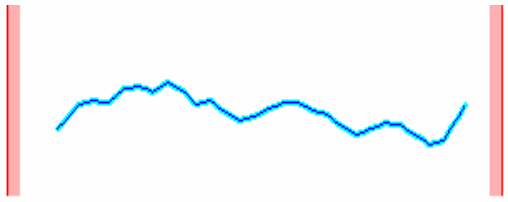
APPENDIX A

A-1 Snapshots of Pitch for Emotional Sentences taken from PRAAT

EMOTIONAL SENTENCES

Sentence 1: *Ajj bazaar band ay*

Speaker 1



Natural Pitch Sequence: LH*L*HLHL

Happy Pitch Sequence: LHLLH*L

Sad Pitch Sequence: HLLLL*L

Angry Pitch Sequence: LHLHL*H*

APPENDIX B

B-1: F_0 Transitions, Average F_0 and Pitch Pattern for Sentence "Ajj bazaar band ay"

Natural

	1st trans.	*2nd trans.*	*3rd trans.*	*4th trans.*	*5th trans.*	*6th trans.*	*7th trans.*	*Avg F_0*	*Pattern*
Spk1.avg	129.3	162.3	130.7	144.8	117.5	129.6	109.2	131.49	LH*L*HLHL%
Spk2.avg	140.9	155.6	135.8	138	133.6	110.2		135.68	LH*L*HLL%
Spk3.avg	112.1	155.9	112.2	120	104.7	115	98.7	116.94	LH*L*HLHL%
Spk4.avg	149.3	182.3	150.7	164.8	137.5	149.6	129.2	151.55	LH*L*HLHL%
Spk5.avg	160.9	185.6	155.8	158	153.6	130.2		155.61	LH*L*HLL%
Avg	138.5	168.34	137.04	145.12	129.38	126.9	112.3	138.25	

Happy

	1st trans.	*2nd trans.*	*3rd trans.*	*4th trans.*	*5th trans.*	*6th trans.*	*7th trans.*	*Avg F_0*	*Pattern*
Spk1.avg	149.6	238.5	169.4	180.6	300.5	223.4		180.285	LHLLH*L%
Spk2.avg	154.8	189	144.8	113.3	165.4	155.2	185.7	158.31	LHLLH*LH*%
Spk3.avg	110	162	117.3	115.9	129.4	166.1	125.9	132.37	LHLLH*HL%
Spk4.avg	169.6	258.5	189.4	200.6	320.5	243.4		200.24	LHLLH*L%
Spk5.avg	164.8	209	164.8	133.3	185.4	175.2	205.7	178.42	LHLLH*LH*%
Avg	149.76	214.4	157.14	148.74	220.24	192.7	172.4	169.92	

Sad

	1st trans.	*2nd trans.*	*3rd trans.*	*4th trans.*	*5th trans.*	*6th trans.*	*7th trans.*	*Avg F_0*	*Pattern*
Spk1.avg	126.9	103.7	115.1	96.3	108.1	89.4		106.58	HLLLL*L%
Spk2.avg	146.7	129.8	128.6	124.5	119.5	114.5	110.4	124.81	HLLLLL*L%
Spk3.avg	141.4	130.9	112.3	123.5	120.1	109.9	103.2	120.18	HLLHL*LL%
Spk4.avg	146.9	123.7	135.1	116.3	128.1	209.4		109.96	HLLLL*L%
Spk5.avg	161.4	150.9	132.3	143.5	140.1	129.9	123.2	140.28	HLLHL*LL%
Avg	144.66	127.8	124.68	120.82	123.18	130.6	112.3	120.36	

Anger

	1st trans.	*2nd trans.*	*3rd trans.*	*4th trans.*	*5th trans.*	*6th trans.*	*7th trans.*	*Avg F_0*	*Pattern*
Spk1.avg	180.8	227.9	174.1	235.9	165.5	261.3	152.5	199.71	LLLHL*HL%
Spk2.avg	150.5	200.3	147.9	216.2	98.4	238.3	124.7	168.04	LHLHL*HL%
Spk3.avg	120.4	111.8	110.3	137.8	116.2	167.5	160.4	132.05	LLLHL*HL%
Spk4.avg	200.8	247.9	194.1	255.9	185.5	281.3	172.5	209.71	LLLHL*HL%
Spk5.avg	140.4	131.8	130.3	157.8	136.2	187.5	180.4	152.35	LLLHL*HL%
Avg	158.58	183.94	151.34	180.72	140.36	227.18	158.1	172.37	

B-2: F_0 Transitions, Average F_0 and Pitch Pattern for Sentence "O sergi waylay aarea ay"

Natural

	1st trans.	*2nd trans.*	*3rd trans.*	*4th trans.*	*5th trans.*	*6th trans.*	*7th trans.*	*Avg F_0*	*Pattern*
Spk1.avg	171.5	140	160.5	123.9	137	124.4		142.88	HLHL*LL*%
Spk2.avg	174.1	146.6	149.8	168.8	157.8	134.1	118.5	145.93	HLHL*LL*%
Spk3.avg	127	167.4	106.5	168.7	106.1	174.3	109.4	137.05	HLHLHL*%
Spk4.avg	157	187.4	126.5	188.7	126.1	194.3	129.4	157.51	HLHLHL*%
Spk5.avg	191.5	160	180.5	143.9	157	144.4		162.81	HLHL*LL*%
Avg	164.22	160.28	144.76	158.8	136.8	154.3	119.1	149.23	

Happiness

	1st trans.	*2nd trans.*	*3rd trans.*	*4th trans.*	*5th trans.*	*6th trans.*	*7th trans.*	*Avg F_0*	*Pattern*
Spk1.avg	160.4	190.6	155.9	212	130.5	170.1	145.8	166.47	LHLHL*HLL%
Spk2.avg	164.7	189.5	155.5	202.8	139.6	175.1	123.5	164.38	LHLHL*HL%
Spk3.avg	154.4	124.6	134.5	121.5	176.6	130.3	161.7	141.53	LHLHL*HL%
Spk4.avg	184.7	209.5	175.5	222.8	159.6	195.1	143.5	184.37	LHLHL*HL%
Spk5.avg	180.4	200.6	175.9	232	150.5	190.1	165.8	186.61	LHLHL*HL%
Avg	168.92	182.96	159.46	198.22	151.36	172.14	148.06	168.67	

Sadness

	1st trans.	*2nd trans.*	*3rd trans.*	*4th trans.*	*5th trans.*	*6th trans.*	*7th trans.*	*Avg F_0*	*Pattern*
Spk1.avg	155.4	132.4	149.8	119.1	148.7	107.9		135.55	HL*HLHL%
Spk2.avg	150.4	130.3	153.8	120.9	144.4	102.2		133.66	HL*HLHL%
Spk3.avg	111.4	135	114	133.6	100.3	548.5	90.3	176.15	HL*HLHL%
Spk4.avg	131.4	155	134	153.6	120.3	568.5	110.3	196.45	HL*HLHL%
Spk5.avg	175.4	152.4	169.8	139.1	168.7	127.9		155.97	HL*HLHL%
Avg	144.8	141.02	144.28	133.26	136.48	291	100.3	159.55	

Anger

	1st trans.	*2nd trans.*	*3rd trans.*	*4th trans.*	*5th trans.*	*6th trans.*	*7th trans.*	*Avg F_0*	*Pattern*
Spk1.avg	129.3	170.5	150	140.7	235.9	261.3	135.5	174.74	LHLLH*H*L%
Spk2.avg	175.7	224.8	189.2	195.9	242.5	251.3	125	200.62	LHLLH*H*L%
Spk3.avg	161.7	126.7	142	176.7	152	182.7	246.2	171.05	LHLLH*H*L%
Spk4.avg	149.3	190.5	170	160.7	255.9	281.3	155.5	194.49	LHLLH*H*L%
Spk5.avg	195.7	254.8	209.2	205.9	262.5	271.3	145	240.33	LHLLH*H*L%
Avg	162.34	193.46	172.08	175.98	229.76	249.58	161.44	196.24	