

Measuring Pitch with Historic Phonetic Devices

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Abstract

Recording the pitch and the intonation contour of spoken words and sentences has been focused by phonetic and linguistic research for a long time. It was recognized very soon that a sufficient description is not possible by human hearing alone. Instead, experiments and measuring devices had to be developed for pitch analysis. However, the investigations offered a lot of problems and were very time-consuming.

This paper describes methods and equipment for the measurement of pitch from the early days of experimental phonetics. We furthermore discuss the measuring accuracy and the subsequent development. The presentation is basing on objects from the collection of historic phonetic devices owned by our institute.

The collection at TU Dresden

At the Laboratory of Acoustics and Speech Communication of the Dresden University, a historic collection of equipment for experimental phonetics and speech communication has been installed. Until now, photographs have been taken for a web presentation which will be installed in next future. Apart from that, selected devices are reconstructed and prepared for demonstrations in suited lectures (e. g., in psychoacoustics, signal processing, and speech technology). Until now, we demonstrated the chain of the following three items [1]:

- sound production (by the larynx model of Wethlo combined with a vocal tract model) [2],
- sound recording (by a kymograph),
- sound analysis (by a mechanical Fourier analyzer).

This presentation describes our activities to install the second of these three items.

Historic aspects of pitch analysis

“Pitch determination is one of the most important but also most delicate problems in speech analysis.” This statement from the standard book on electronic means in this field (Hess 1983 [3]) describes a scientific problem which was known long time before the computer found its way into the phonetic laboratories. Phoneticians became aware of the importance of pitch measurement approx. 100 years ago [4]. How did they do that without electronic means?

The “kymographion” formed the basic device for this purpose for a long time [6]. It follows the principle to record a waveform on a registration area which is moved by a driving force. Its idea was applied for first time in 1734 for

registering the parameters of the wind (Anemograph by Onsen-Bray). The later standard configuration was introduced by Ludwig 1847 and developed during the following decades. It consists of the following main components:

- a revolving drum
- clock mechanism for driving the drum
- paper blackened with soot as registration medium

This standard device was produced industrially and worldwide used.

Depending on the application, different recording tools (writers) had to be added to the kymograph to produce a curve on the sooted paper. For recording a sound, a writer from Krüger-Wirth was used since 1905 among other constructions. From the recorded waveform, the pitch contour had to be calculated. E. A. Meyer developed a tool which supported this process [7]. It was improved in 1913 by Stilke and Schneider [8].

The writers were improved also. In 1916, Calzia and Schneider published the description of a writer (“Throat sound recorder”) able to register vibrations up to 900 Hz which is sufficient for pitch measurements [9]. This was a very delicate construction with a blade of straw combined with a pig bristle as writing pen. A kymograph equipped with this writer shown in Figure 1 forms the prototype for our reconstruction. Later, the writer was further improved to work in a frequency range of 200 Hz ... 2000 Hz [10].

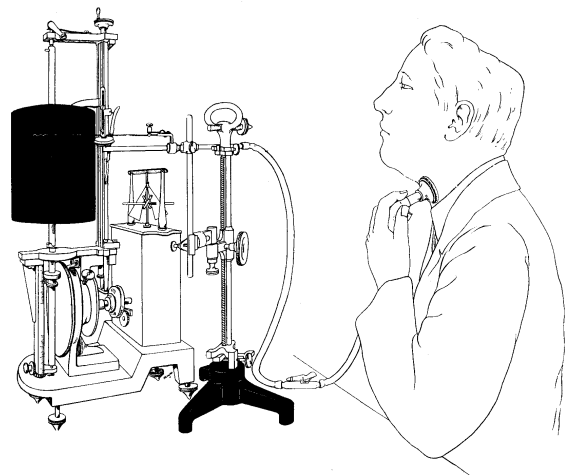


Figure 1: The prototype for our reconstruction (picture from Palconcelli-Calzia 1922 [5]).

The kymograph was used for a long time. It must be mentioned that the well-known phonetician Franz Wethlo improved the kymographic pitch measurement until 1954 [11]! The kymograph itself was further developed, e. g. by an electrical drive, and produced in different versions until it was replaced by electronic devices.

The reconstructed device

Figure 2 shows the reconstructed arrangement for pitch measurements. It consists of the following parts which are partially described in the catalogue of the producer [12]:

- Universal kymograph
- Registration paper blackened with soot
- Throat sound recorder (“Kehltonschreiber”)
- Chronograph
- Universal tripod

The adapter capsule of the throat sound recorder is a replica.

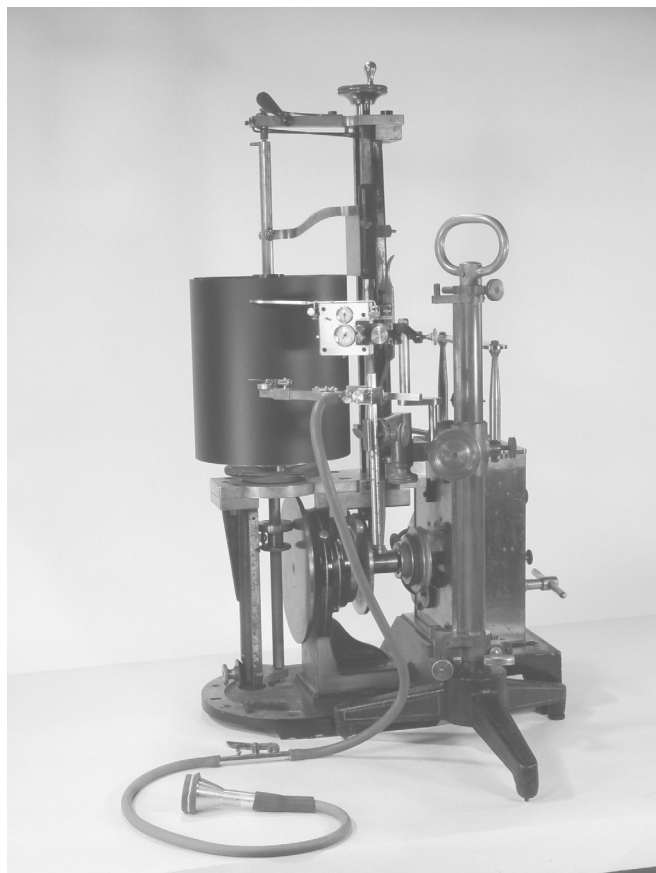


Figure 2: The reconstructed arrangement.

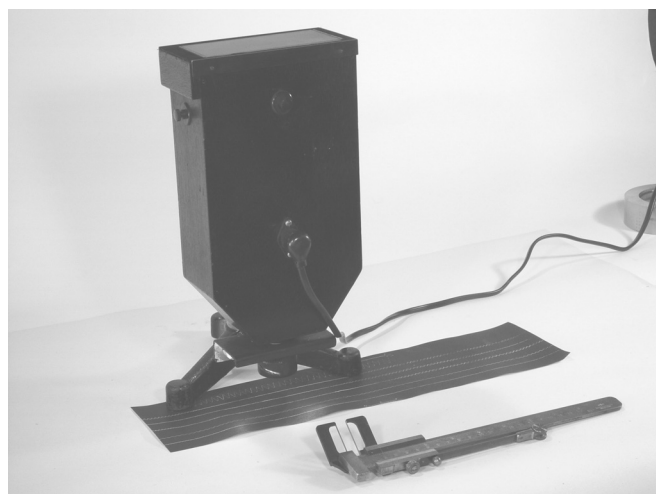


Figure 3: The original aids from F. Wethlo for easier interpretation of the recorded waveforms.

Aids for interpreting the results

Finally, we want to mention that we reconstructed the measuring projector introduced by Wethlo in [11] (Figure 3). This device makes the interpretation of the recorded waveforms easier by magnification (10 x) and illumination. The length of a period of the magnified waveform is measured by the special vernier gauge coming from Wethlo's estate as well.

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