How to declick an archive soundfile

About DART DeClick

Archive recordings are corrupted with many different kinds of disturbances. Among the most frequently encountered ones are impulsive disturbances (clicks, pops, scratches) and wideband noise (tape hiss, surface noise of vinyl records) caused by aging and/or mishandling of recording media such as vinyl records or magnetic tapes. The DART's (Digital Audio Restoration Technology) **DeClick** plug-in is a procedure for elimination of impulsive disturbances and low intensity wideband noise. Based on indications of an outlier detector - a device which searches for noise pulses - the system isolates and reconstructs the irrevocably distorted signal samples. Upon request a low intensity background noise can also be removed in the same pass of the renovation program.

How to Tune DeClick

The adaptive renovation filter - the heart of DART **DeClick** - is a sophisticated algorithm designed to simultaneously track time-varying characteristics of a processed audio signal, isolate and reconstruct irrevocably distorted samples (e.g. samples corrupted with clicks, pops, record scratches and other forms of impulsive noise), and remove broadband noise (e.g. surface noise or tape hiss).

Processing is done in two stages. First, impulsive disturbances are removed along with a portion of wide-band noise. Then a special adaptive postfiltering technique is used to further reduce the noise. Even though you can achieve noise reduction by means of “smoothing” only (postfiltering factor set to zero), or “postfiltering” only (smoothing factor set to zero), the best results are obtained when both actions are combined and applied appropriately.

Adjusting Renovation Coefficients

There are four important tuning parameters which can be used to influence the process of signal renovation: smoothing factor, postfiltering factor, detection threshold and maximum length of detection alarms

Smoothing factor

A special adaptive version of a device known as the Kalman filter is used to smooth/reconstruct the signal at the first stage of the noise canceling procedure. The smoothing coefficient can be chosen in the range <0.0, 2.0> and decides upon the degree of smoothing to be introduced by the filter. Generally, smoothing factors smaller than 0.1 are recommended (0.05 is a default 'first try' value), since they result in a very gentle smoothing action, retaining the clearness and freshness of the original sound, while at the same time, reducing the noise. Selecting greater values of the smoothing factor may (but not desirably) result in a sound which is relatively clean but muffled and dull.

If the noise level is low, smoothing may be all that you need. If the noise intensity is high, smoothing may produce hissing artifacts - do not worry, postfiltering will take care of it!
Smoothing can be turned off by unchecking the smoothing box (which is equivalent to setting the corresponding coefficient to zero).

Postfiltering factor

A special postfiltering algorithm was designed for the purpose of adaptive canceling of wide-band noise. It is very effective in reducing the tape hiss and surface noise, and can be used for 'cleaning up' the signal produced by a Kalman smoother.

The postfiltering device operates in a different way than the smoothing device. While smoothing is generally uniform, postfiltering is selective - it can provide considerable rates of noise suppression on silent parts of the recording and still retain sharpness and freshness of the original sound in its louder parts, where the noise is less audible.

Even though the postfiltering factor can be chosen in the range <0.0, 2.0>, values smaller than 0.5 are recommended (the default value is 0.2). If the value of the postfiltering coefficient is too large, the sound may turn out to be unclear and reverberant.

Postfiltering can be turned off by unchecking the postfiltering box (which is equivalent to setting the corresponding coefficient to zero)

Detection threshold

Detection threshold decides about the sensitivity of the outlier detector, a device used to localize impulsive disturbances. It can be chosen in the range <3.0,10.0>. The recommended (default) value of the detection threshold is 3.5. The values smaller than 3.5 may result in an overly 'fussy' detection scheme, i.e., scheme which raises too many false alarms introducing noticeable signal distortions and slowing down computation. On the other hand, when relatively large values of detection threshold are adopted, the detector may become too 'tolerant' and fail to isolate small noise pulses.

When so required, the outlier detector can be turned off.

NOTICE
With the smoothing and postfiltering factors both set to zero, the restoration program will perform declicking and decrackling of the recording without attempting to remove the broadband noise (all samples except those classified as outliers will be preserved without changes). If the outlier detector is also turned off, the renovated soundfile will be identical with the source file - which looks pretty much like wasting the computer time (after all, there are simpler ways of copying one file to another ...).

Maximum length of detection alarms

The maximum length of detection alarms, which can be chosen in the range <1,100>, determines the maximum number of samples in a row that can be scheduled for reconstruction in the automatic detection mode. The recommended (default) value of this constant is 50. When false alarms are raised the system is more prune to introducing audible distortions if the maximum allowable size of reconstructed fragments is large. For this reason one should keep this constant as *small* as necessary.

The length of noise pulses depends on several factors :

- Sampling frequency - quite obviously for higher sampling rates a larger number of samples becomes corrupted with a click of a specific duration.
- Recording medium (magnetic tape, vinyl record) and degree of its degradation.
- Recording conditions and/or equipment used for playing back an archive recording.

The maximum length of detection alarms should fit characteristics of impulsive disturbances encountered in the processed audio file. For example, if you process audio material from a moderately used vinyl record (with no big scratches on it) you can safely limit the size of reconstructed blocks to 10-20 samples for 22 kHz sampling or to 20-40 samples for 44 kHz sampling. For the real 'oldies', however, it might be necessary to work with considerably larger block sizes.

Selecting the Mode of Processing

The voiced speech sounds (such as vowels) can be regarded as a result of exciting a linear filter (representing a vocal tract) with a pseudo-periodic train of impulses, called pitch excitation (representing vibrations of vocal cords). The impulsive nature of the voiced speech formation makes the task of speech declicking and decrackling particularly difficult as pitch-related pulses can be easily confused with noise pulses, i.e., pulses caused by clicks or record scratches.

A special routine was designed to block the outlier detector at instants where the pitch excitation is expected. In order to activate this device you should choose the *music & speech* option.
As general guidelines use the following :

- Choose *music* to process instrumental music and most of the vocal music (songs, choruses) - with some rare exceptions discussed below.
- Choose *music & speech* to process pure speech or speech mixed with music (as in radio broadcasts). Some songs contain very strong voiced speech components (especially when the supporting music is weak), and hence, should be renovated using the *music & speech* option.

The *music & speech* version of the renovation program applied to the restoration of instrumental or vocal music will generally work slightly slower than the corresponding *music* version. Additionally, it may produce slightly inferior results - due to the 'detector masking' effects, some of the clicks may be overlooked.

General guidelines

Instead of trying to tune **DeClick** using the whole recording (which may be very time consuming for large soundfiles), you may consider performing several quick tests on a short 'representative' fragment of the original material. If necessary, you can repeat this procedure several times for different parameter settings until the results are satisfactory. We suggest that you start the tuning process from the default values of the smoothing factor, postfiltering factor and detection threshold. In most cases, the default settings produce very good results !

When tuning the renovation filter, you have to rely on your own subjective evaluation of the results. Even though, as the Romans used to say, "De gustibus non est disputandum" ("There is no accounting for tastes"), we beg you: please, do not forget about the signal in your pursuit of removing the noise. Adopting values that are too large in the smoothing factor and/or the postfiltering factor may result in a sound which is noiseless, but sounds DEAD.

Upgrade to DART PRO 32

DART DeClick provides you with the best declicking algorithm on the industry. DeClick is one of the six reiteration functions found in DART PRO 32 (DeClick, DeHiss, DeNoise, ReTouch, Duplicate, and Filter Builder). DART PRO 32 is the best audio restoration system in the business and it works on both instrumental and voice recordings. You can upgrade to DART PRO 32 which includes the best and most complete audio restoration functions in the business, a complete audio editing and signal processing system, graphics interfaces, CD-R playlist organizer and writer, and a multimedia audio restoration tutorial. You can call us toll-free at 800-799-1692 or 612-844-0217. A special upgrade price is available to all DART customers.

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