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Tunepal: The Traditional Musician's Toolbox

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ABSTRACT

In this paper we present Tunepal, a search engine and music retrieval tool for traditional musicians that runs on an iPhone/iPod Touch (2nd generation)/iPad. Tunepal connects musicians the scores and metadata of 13,290 traditional Irish, Welsh, Scottish and Breton dance tunes. These tunes are drawn from community sources, such as the website thesession.org and “standard” references including O’Neills Dance Music of Ireland and Brendan Breathneach’s Ceol Rince Na hÉireann series. Tunes can be retrieved by typing in a title or by playing a twelve second extract from the tune on a traditional instrument. Tunepal can be used *in situ* in traditional music sessions, classes and concerts. This paper presents background information on the sources of music contained in the Tunepal corpus and describes the functionality, operation, development and usage of the app.

Categories and Subject Descriptors

H.5.5 [Sound and Music Computing]: Systems

General Terms

Algorithms, Measurement, Performance, Design, Experimentation, Human Factors.

Keywords

Music Information Retrieval, Traditional Irish Music, Query-By-Playing, ABC, iPhone, Android

1. INTRODUCTION

In common with the folk music of many countries, repertoire in Irish traditional music is primarily acquired aurally. Musicians playing Irish music learn by hearing tunes played by fellow musicians [1] rather than from tune books. Since the 1960's it is common for musicians to play and learn tunes in *sessions* – semi-formal gatherings of musicians and occasionally dancers that often take place in pubs (Figure 1). Often sessions are anchored by one or two core musicians who may be paid to play, though sessions are generally open to guests of appropriate standard. Because of the significant size of the canon of traditional music (over seven thousand compositions) many musicians playing music in sessions are unaware of the title or origin of the tunes they play [2].

In this paper, we present Tunepal – an iPhone app that can be used *in situ* in traditional music sessions to access collections of

traditional music. Tunepal is the evolution of a ten year project at the Dublin Institute of Technology to connect the playing of traditional music with useful metadata about the music such as tune names, composers and discographies. The Tunepal corpus contains 13,290 tunes drawn from community sources, such as the website thesession.org [3] and “standard” references including O’Neills Dance Music of Ireland [4] and Brendan Breathneach’s Ceol Rince Na hÉireann series in five volumes [5]. Our corpus also includes collections of Welsh, Scottish, Breton, Canadian old time, Quebecois and American Old Time/Appalachian music in addition to several different transcriptions of the same tune from the canon of Irish traditional music. The corpus can be searched by entering a tune name or by playing a twelve second extract of a tune on a traditional instrument such as the flute, uilleann pipes, fiddle or concertina into the iPhone microphone.



Figure 1: Fiddle player Colm Logue, the author, and flute player Patsy Hanley at an informal session at Fleadh Cheoil na hÉireann 2008

Section 2 of this paper presents some background information on the collections of music used in the Tunepal corpus. Section 3 of the paper describes the functionality and operation of Tunepal for iPhone/iPod Touch (2nd generation)/iPad. Section 4 presents usage results, while section 5 presents conclusions and future work.

2. BACKGROUND

Irish traditional music includes several musical *forms*. In the song tradition, both sean nós (“old style” singing in the Irish language) and singing in English exist. The baroque music of Turlough O’Carolan is also considered part of the tradition [6]. This paper however, is primarily concerned with traditional *dance* music. The canon of Irish traditional dance music includes at least seven thousand unique compositions [2]. The most common forms of dance tunes are: *reels*, *double jigs* and *hornpipes*. Other tune types

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include *marches, set dances, polkas, mazurkas, slip jigs, single jigs and reels, flings, highlands, scottisches, barn dances, strathspeys and waltzes*[7]. These forms differ in time signature, tempo and structure. For example a reel is generally played at a lively tempo and is in 4/4 time (written as eight quavers in a bar) while a waltz is generally played at slower pace and is in 3/4 time. The time signature, tempo and structure of a tune form are determined by the dance it accompanies. Most tunes consist of a common structure of two parts traditional musicians refer to as the *A* part and *B* part. Musicians playing traditional music have a personal repertoire of up to a thousand tunes. Many of these tunes are known by multiple names, while many more are known simply as “gan anim” (without name) [2]. In the modern age, Irish traditional musicians play fiddles, uilleann pipes, tin-whistles, flutes, concertina’s accordions, banjos and harps. Other less popular instruments include the mandolin, harmonica and dulcimer [6].

2.1 Collections

There have been several notable initiatives to catalogue the canon of Irish traditional music [8-11] but the majority of traditional tunes were not transcribed until the turn of the twentieth century when Francis O’Neill, the then police chief in Chicago, transcribed and documented a large body of dance tunes and airs from immigrant Irish musicians.

In 1903, he published a book of his collected tunes entitled *The Music of Ireland*. The 1,850 tunes presented in the collection were classified according to tune-type (airs and songs, Carolan compositions, double jigs, slip jigs, reels, hornpipes, long dances, marches and miscellaneous). In 1907, he published *The Dance Music of Ireland – 1001 Gems*. This collection focused entirely on the dance music repertoire and contained many tunes published in his previous collection. O’Neill’s second book was considered the definitive source for traditional musicians and musicians would often refer to a tune by its reference number in the book [1].

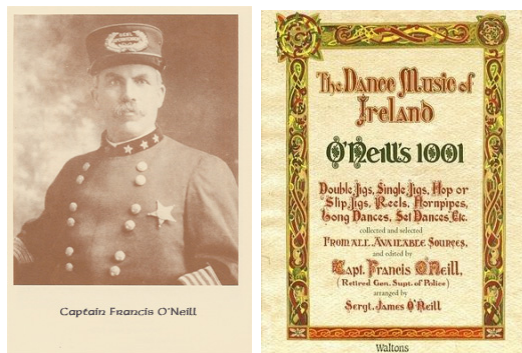


Figure 2: Police Chief Francis O’Neill and the cover of O’Neill’s “The Dance Music of Ireland”

Brendan Breathnach’s *Ceol Rince Na hÉireann* series in five volumes is regarded as the most significant and influential collection of traditional Irish music after O’Neill’s books [5]. Breathnach’s books contain tunes from many sources including field recordings, commercial recordings and manuscript collections of dance music held in private hands.

By identifying duplicates and variations Breathnach sought to identify the earliest occurrences of tunes and trace their history

through printed manuscript collections and recordings. His books contain detailed bibliographic notes on each of the tunes included.

2.2 Collections in electronic format

ABC is a music notation language introduced by Chris Walshaw in 1991 [12] for typesetting traditional tunes. The format was designed primarily for folk and traditional tunes of Western European origin which can be written on one staff in standard classical notation [12]. The tune given in Figure 3 is typical of the transcriptions that can be sourced in ABC from publicly available databases.

```
X:549
T:Kiss the Maid behind the Barrel
R:reel
H:Similar to "Trim the Velvet", #2
Z:id:hn-reel-549
M:C|
K:G
DG~G2 AG~G2|DG~G2 cAFA|DG~G2 ADFA|defd
cAFA:|
dg~g2 aggf|dg~g2 agfe|df~f2 af~f2|defd cAFA|
...
"variations"
|:DG~G2 AG~G2|dG~G2 cAGF|DG~G2 ADFA|1 defd
cAGF:|2 defd cAFA||
...

```

Figure 3: An extract from the tune “Kiss the Maid behind the Barrel” in ABC notation [13]

In this transcription the transcriber has helpfully included useful metadata with the notation for the tune such as similar tunes and variations. ABC files are ASCII text files and so can be edited by any text editor, without the necessity for special software. Each file (known as a *tune book*) can contain multiple tunes. File sizes are typically measured in kilobytes and this facilitates easy transmission over the internet. The small size of ABC files also makes them an ideal medium for the storage of tunes on a memory constrained mobile device [14].

The header section contains amongst other fields, the title, composer, source, tempo, key, geographical origin and transcriber [15]. As tunes can have several titles, the title field can be repeated for a given tune. The tune body contains the notation for the tune. The body encoding supports such features as ornaments, bar divisions, sharps, flats, naturals, repeated sections, key changes, guitar chords, lyrics and variations. There is an active and vibrant community supporting ABC notation and a range of tools have been developed for a variety of platforms and purposes.

Between 1997 and 2000, a group of musicians under the leadership of Dan Beimbom and John Chambers, undertook a grass roots project to transcribe three of O’Neill’s books to electronic format using ABC notation. As copyright had expired on O’Neill’s original books, they made their work freely available on the internet [16]. Many of the tunes from O’Neill’s books are played differently by musicians today, as is normal with a living tradition. Around the same period (the late 1990’s) Henrik Norbeck collected nearly two thousand tunes in ABC notation from various sessions and recordings. Again this collection was made freely available on the internet. This collection contains many modern settings of tunes from O’Neill’s books [13]. Similarly, Bill Black a musician from Cape Cod, USA has

transcribed all of Breathneach’s books in ABC notation and made these freely available on the internet.

Website thesession.org [17] contains an extensive; crowd-sourced collection of over seven thousand traditional Irish dance tunes in ABC notation entered by the traditional music community. The collection can be searched using text queries by any of the metadata associated with a tune or by melodic queries in ABC notation. The website is significant, because it is supported by an active community of thousands of musicians who regularly contribute tunes, report on traditional music sessions and engage in lively discussions.

3. TUNEPAL

The main contribution of this paper is Tunepal; a musician’s toolbox that can be conveniently and discretely used in traditional music sessions to access to the collection described in section 2.1 and 2.2 on an iPhone, iPod touch (2nd generation) or iPad. It can be used to find a tune by a title that the user might wish to play or to identify a tune played by other musicians. The corpus consists of 13,290 tunes. These are not in fact stored on the iPhone itself. Instead, the corpus is stored “in the cloud” on the tunepal.org server that can be accessed via the Tunepal for iPhone client program. Table 1 presents a summary of the sources of tunes used in the Tunepal corpus.

Table 1: Sources of tunes in the Tunepal corpus

Source	Count
thesession.org	9,310
Henrik Norbeck	1,474
O’Neills Dance Music of Ireland	994
Ceol Rince na hÉireann 1	73
Ceol Rince na hÉireann 2	192
Ceol Rince na hÉireann 3	37
Ceol Rince na hÉireann 4	220
Jonny O’Leary	196
Nigel Gatherer	794
Total:	13,290

To find a tune, a musician can either type in the title of the tune, or record a twelve second extract played on an instrument such as the concert flute, tin-whistle, uilleann pipes, accordion or concertina. The query is then submitted over the internet to the tunepal.org server for matching. tunepal.org returns the ABC notation for matching tunes with metadata such as titles and key signature as an XML document. Figure 5 shows an extract from a tune XML document.

```

<tune>
<title>Kiss The Maid Behind The
Barrel</title><alt_title></alt_title><x>676<
/x><id>5621</id><tunepalid>676-6.abc-1-
Kiss~The~Maid~Behind~The~Barrel</tunepalid><
source>thesession.org</source><sourceid>1</s
ourceid><type>reel</type><notation>X:676&#xD
;
T:Kiss The Maid Behind The Barrel&#xD;
M:4/4&#xD;
L:1/8&#xD;
R:reel&#xD;
K:Gmaj&#xD;
|: DG~G2 AG (3GGG | DG~G2 cAFA | DG~G2 ADFA
| defd cAFA :|&#xD;
dg~g2 aggf | dg~g2 agfe | df~f2 af~f2 | defd
cAFA |&#xD;
...
</notation><search_keys><key>DGGGAGGGGDGGGCA
FADGGGADFADFDFDCAFADGGGAGGGGDGGGCAFADGGGADFAD
EFDCAFADGGGAGGFDDGGGAGFEDFFFAFFDFDFDCAFADGGGA
GFGAAAGFFFGAFGEFDECDDEGFDCAGGDGBGDGGGDBCAFAFAG
GDGBGCDEFDFDCAFAGGDGBGDGGGDBCAFABBBGADFADFDFDC
AFABBBGAAAGBABDGEDCBBGBADFADFDFDCAFABBBGAAAGB
ABDGEDCBBGGADFADFDFDCAFADFAFA</key></search_keys>
</tune>

```

Figure 5: Tune XML document

Figure 4 presents a high level diagram of the subsystems that make up Tunepal. These will now be described.

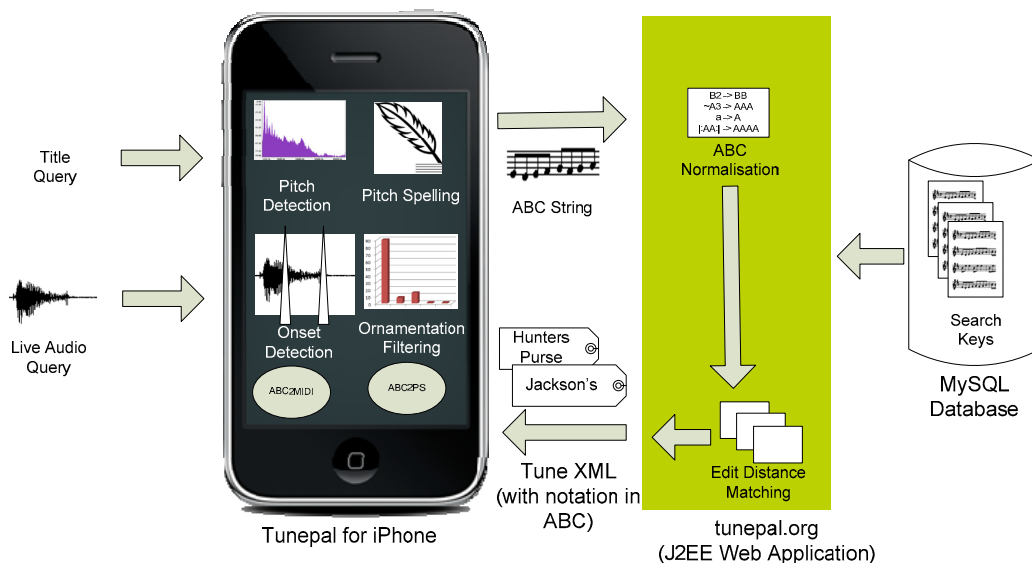


Figure 4: A high level diagram of the subsystems in Tunepal

For live audio queries, the audio is sampled at a rate of 22.05KHz, with 16 bit resolution. Note onset detection is achieved using a combination of an STFT (Short-time Fourier Transform) with a Hanning window and a pitch spelling algorithm. An STFT is carried out on the signal using a frame size of 2,048 samples, with a 50% overlap. This gives a frequency resolution of 10.76Hz, discriminant enough to detect pitches of traditional instruments without interpolation. A harmonicity based, pitch detection algorithm [18] that analyses peak intervals in the frequency spectrum is used to estimate the perceived frequency. Identified frequencies are then assigned pitch classes using a pitch spelling algorithm. The pitch spelling algorithm spells pitches as if they were played on a D tin whistle or flute (the most common fundamental note in traditional music), though users can also change the transcription fundamental (Table 2).

Table 2: Fundamental notes for traditional instruments

Key	Fundamental note (Hz)
Bb	233.08
B	246.94
C	261.63
D	293.66
Eb	311.12
F	349.23
G	392.00

This changes the frequencies used by the pitch spelling algorithm, so that Tunepal can work with differently pitched instruments, such as Eb flutes and uilleann pipes pitched in B and C. A note onset is annotated when the pitch class changes in the time domain.

Tunepal attempts to remove ornamentation notes from the transcription as described in [19] by quantising notes to the nearest quaver multiple. The quaver length is first determined using the fuzzy histogram clustering algorithm described in [18,20,19]. Ornamentation notes are then removed from the transcription and long notes (crochets, dotted crochets) are split into multiple quaver notes. The transcription string (a sequence of pitch classes spelled in ABC notation) is then submitted to over the internet to the matching engine, a J2EE web application; hosted on tunepal.org. The matching engine uses the substring edit distance algorithm [21] against the corpus of *search keys* - strings of musical notes extracted from the tunes and normalised as described in [18,19]. These are stored in a MySQL database.

For each search key in the database, the matching engine computes the minimum substring edit distance between the query and the search key by generating an edit distance profile for the query (Table 3).

Table 3: Example edit distance profile (the bottom row)

		D	G	G	G	D	G	B	D	E	F	G	A	B
	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	1	1	1	1	1	1	1	0	1	1	1	1	1	0
D	2	1	2	2	2	1	2	1	0	1	2	2	2	1
E	3	2	2	3	3	2	2	2	1	0	1	2	3	2
E	4	3	3	3	4	3	3	3	2	1	1	2	3	3

For each submitted query, tunepal.org presents the ten closest matches in order of descending distance from the query. A confidence score is calculated as per (1) where q is the query length and ed is the minimum substring edit distance between the query and the closest match [6].

$$(1)$$

Using this approach returns the correct tune as the closest match for 93% of queries in experiments using real-world field recordings of traditional musicians from sessions, classes, concerts and commercial recordings including solo and ensemble playing on traditional instruments recorded in a variety of real-world settings such as noisy public sessions [19]. Tunepal returns the top ten closest matching tunes for a query with confidence scores (Figure 6).

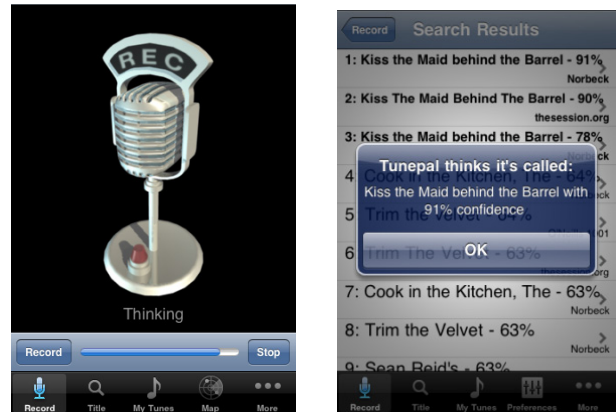


Figure 6: Tunepal query-by-playing search

This is particularly useful as the same tune often appears in multiple collections.

Retrieved tunes can be stored in a “My Tunes” tab on the user’s device, in order of most recently tagged to facilitate future retrieval for learning purposes. Once a tune is retrieved, it can be displayed in ABC notation or stave notation, emailed, posted to Facebook or played back. Playback is achieved using ABC2MIDI [22] and the FMOD audio engine [23]. Playback can be speeded up, slowed down or transposed (Figure 7). Playback is perhaps the most useful way to present tunes given that many traditional musicians prefer to learn tunes aurally. Playback also facilitates proof listening in order to confirm the accuracy of the returned tune.

We log each query, with the closest matching tune and confidence score. When a tune is matched Tunepal for iPhone offer the option to link back to the original source of the ABC notation on the internet. In the case of tunes indexed from the website thesession.org, this often includes extensive discussions on the origin of the tune, the source of transcription and recordings on which the tune appears.

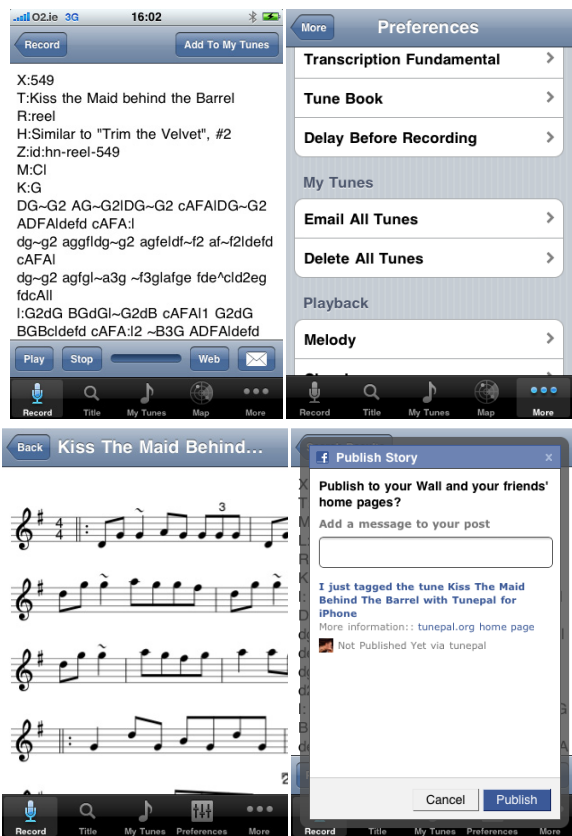


Figure 7: Tunepal screenshots

With the users permission, we also geotag each query on the iPhone and log the longitude and latitude with each query in the tunepal.org database. This makes it possible for a user to track their queries on a map (Figure 8).

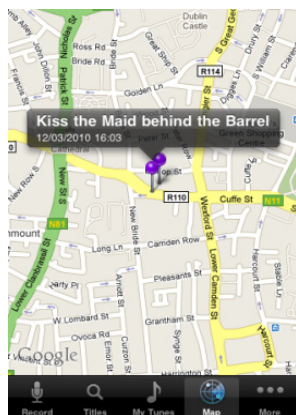


Figure 8: Geotagged tunes displayed within Tunepal on the iPhone

Tunepal was developed in Objective C, C and C++ using the iPhone SDK. The J2EE web application hosted on tunepal.org was developed in Java using NetBeans.

4. RESULTS

Tunepal for iPhone was released on the Apple App Store on 11 February, 2010 and at the time of writing (9 June 2010), 7,828 QBP (Query By Playing) queries have been made, while 4,128 title searches were made. 5,768 of the QBP queries were geotagged (73%), while 3,188 of the title searches were geocoded (77%). Table 4 summaries this information.

Table 4: Query count summary

Queries	Count
QBP Geocoded:	5,768
QBP Non-geocoded:	2,060
Title Geocoded:	3,188
Title Non-geocoded:	940
Total:	11,956

Tunepal now has users in twenty two countries as evidenced by Table 5. Table 5 was generated by reverse geocoding the latitude and longitude of submitted queries using the geonames.org web service.

Table 5: Sources of geocoded queries

Country	QBP	Title	Total
United States	1,820	1387	3,207
Ireland	2,156	911	3,067
United Kingdom	626	490	1,116
Canada	323	30	353
Germany	291	50	341
France	161	98	259
Spain	98	43	141
Sweden	97	10	107
Netherlands	47	33	80
Australia	45	15	60
Austria	0	42	42
Switzerland	17	18	35
Japan	23	8	31
Italy	6	20	26
Norway	18	6	24
South Korea	0	22	22
Denmark	16	0	16
Brazil	12	0	12
New Zealand	7	3	10
Belgium	5	0	5
Hungary	0	1	1
China	0	1	1
Total:	5,768	3,188	8,956

Figure 9 represents the data from Table 5 as a pie chart. It is significant that the UK, Ireland and the US are the main source of queries these being major centres for the Irish diaspora and also countries where traditional music sessions take place regularly.

A live, interactive view of logged queries displayed on a Google map can be viewed on the website tunepal.org.

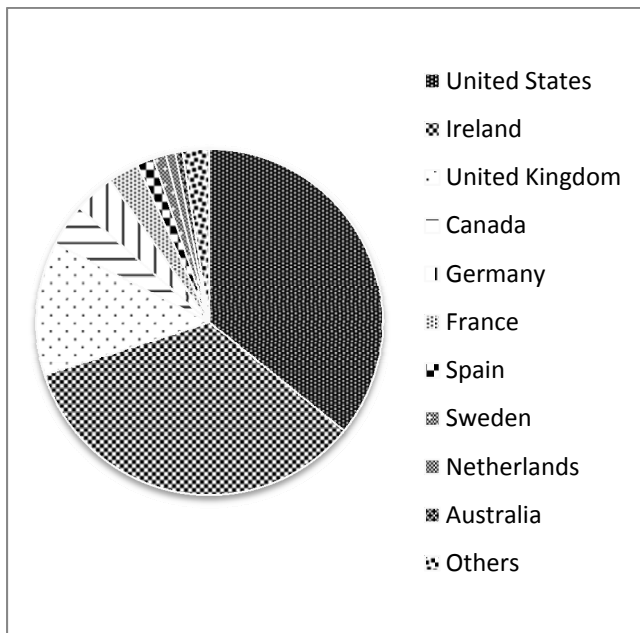


Figure 9: Sources of geocoded queries by country

5. CONCLUSIONS AND FUTURE WORK

In this paper we presented Tunepal for iPhone - a system that connects traditional musicians playing in sessions, classes and concerts with musical cultural heritage. Tunepal supports both title searches live audio queries. To achieve this, we use a corpus of 13,290 compositions collected by noted collectors such as O'Neill and Breathneach and crowd-sourced by the traditional music community. Tunepal can display the stave and playback any composition from the corpus, on an iPhone.

Tunepal has become a popular tool, having been used being used 11,956 times by musicians from twenty two countries. Tunepal for iPhone was listed in the top twenty cultural apps available on the iPhone by the Sunday Times (an Irish national newspaper) alongside apps such as Shazam and Spotify, IMDB and an app from the British National Gallery [24]. Tunepal has also been extensively discussed on traditional Irish music forums [25]. Tunepal has been favourably received and musicians report that the system is being used in variety of scenarios including archiving and the preparation of sleeve notes for commercial recordings. Nevertheless, a minority of musicians report scepticism of the use of technology in traditional music sessions (ironically on internet forums).

It is our aim to further disseminate the Tunepal to the traditional music community by making it available on a greater variety of mobile platforms and an Android version is currently under development.

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