Typical envelopes of a time-series of shape coefficients are plotted in Fig.2.

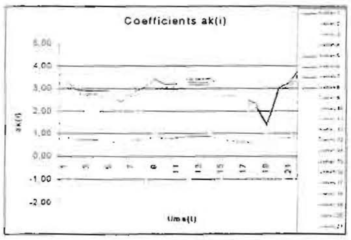

Fig. 2. Functions representing time-variations of typical cardiac left ventricle's shape coefficients.

In cardiac diagnosis a particular interest is paid to detection and evaluation of left ventricle contractility disorders, hidden in the form of $D_k(P)$ function.

Discussion: The kinetic model of left chamber shape variations in time describes well the regional chamber's contractility phenomena.

The model has been used in automatic contouring of the left ventricle in a series of cardiac USG images.

Using the time-series smoothing technique to the shape coefficients of the model a series of refined contours of the object under observation can be obtained, and so, the time-variations of its shape can be examined.

It is possible to evaluate the model coefficients effectively on the basic of computer-aided analysis of series of cardiac images obtained in USG modality, non-invasive for the patients.

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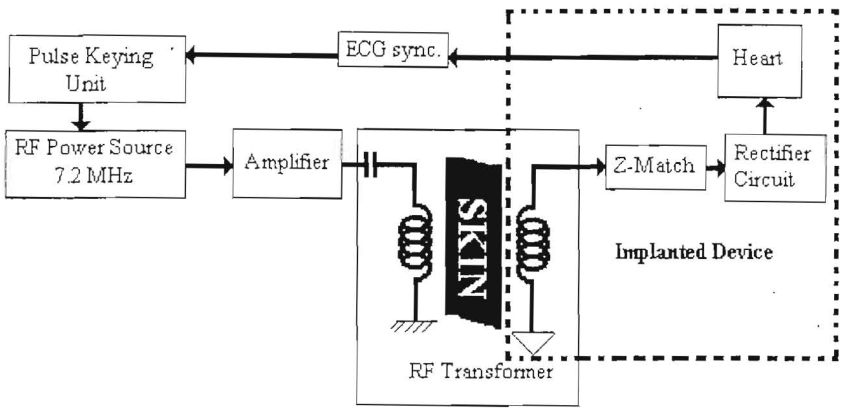
An implantable monophasic/biphasic atrial defibrillation system using transcutaneous RF power delivery

J A Santos[a], G Manoharan[a], N E Evans[a], J McC Anderson[a], B J Kidawi[b], J D Allen[b] and A A J Adgey[b]
[a]*N Ireland Bioengineering Centre, University of Ulster, Northern Ireland, UK*
[b]*Royal Victoria Hospital, Belfast, Northern Ireland, UK*

Aims & Background: Fibrillation is a chaotic electric excitation of the myocardium and results in a loss of the coordinated mechanical contraction characteristics of normal heartbeats. Atrial fibrillation (AF) is the most common arrhythmia, characterised by irregular and chaotic fibrillatory waves that replace the normal P wave of the QRS complex in the ECG. Current methods for defibrillation have varying success rates, risks and cost implications. The aim of this project is to realise a versatile passive implant to effectively treat AF in a risk-cost effective manner.

Methods: In this work we have accomplished defibrillation using a novel transcutaneous technique to deliver a unipolar DC pulse to a passive, battery-free implant. The system consists of a radio frequency (RF) on-off pulsed power source operating at 7.2 MHz and connected to an RF transformer; the latter is built with a series-tuned primary placed on the body surface and a parallel-tuned, intracorporeal secondary acting as the 'receiver.' The receiver's output is matched to the (nominal) 50 Ω resistive load presented by the heart and uses a Schottky diode half-wave rectifier to generate the unipolar stimulus. This is delivered to the load using two leads placed at the distal coronary sinus and atrial appendage.



The device was tested using 10 anaesthetized sheep. Sustained AF was induced by rapid atrial pacing (Grass stimulator, 100 Hz, 5 V) and cardioversion was attempted, synchronized to the QRS complex. The efficacy of three pulse amplitudes (50, 75 and 100 V) was assessed using pulse widths in the range 5 - 30 ms. Defibrillation was repeated 5 times at each voltage and pulse-width setting. The delivered shock voltage and current were captured and stored for later analysis.

Based on the results obtained for this device, a modification was developed to obtain a biphasic waveform in the receiver unit; this accomplishes cardioversion with less pain and less damage to the heart tissue.

Results: In the monophasic device, at 50 V the rate of successful cardioversion was only 40 % for the smaller pulse widths, increasing to 74 % at 30 ms. Success rates were comparable at 75 V. At 100 V, however, 100 % success was observed for 10 ms pulses: this figure fell to 98 % when using 12 and 15 ms widths. The system proved resistant to lateral and angular coil misalignment, while maintaining high power transfer efficiency.

The biphasic device performance was simulated using analog circuit simulators to obtain the values for current and energy delivered to a 50 Ohm load. The total current at full power was 1.92 A, making the energy delivered 1.9 J. This biphasic device is currently being tested at the RVH, Belfast.

Volts	Width (ms)	5	6	8	10	12	15	20	30
50 V	% Success	18	40	48	50	56	64	74	74
75 V	% Success	-	-	52	58	66	66	78	-
100 V	% Success	58	72	88	100	98	98	96	98

Table 1: Cardioversion success rate for different pulse widths and amplitudes

Conclusions: During the experiments on the monophasic device, no arrhythmic complications were observed. Optimum coupling of the transmitting and receiving coils was achieved at 20 mm axial spacing. Complete success at 100 V and 10 ms, or 2 J delivered energy, indicates the strong potential of the technique. The absence of a battery makes the device attractive in terms of minimising potential hazard. This method is an inexpensive and viable alternative treatment for patients suffering paroxysmal AF.

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A new approach to the Holter events classification based on application of wavelet neural network

A. Wrzesniowski[a], E.J. Tkacz[b], P. Kostka[b]

[a]*ASPEL Medical Electronics Ltd., Kraków, Poland*

[b]*Institute of Electronics, Division of Biomedical Electronics, Silesian University of Technology, Gliwice, Poland*

Introduction: Contemporary cardiovascular system diagnostic process requires more and more sophisticated technical facilities and method to ensure the proper diagnosis quality and reliability. Therefore many biomedical engineering centers, both scientific and commercial make search towards new methods allowing implementation in the new diagnostic products. In case of Holter method ECG examination usually the problem of template extraction and further events classification should be solved out. Existing systems apply so called traditional methods requiring definition of several templates from 2-4 leads and then construction of classification process based on comparison of incoming morphology of QRS complexes from particular channel to the established set of templates by calculation of certain factor (e.g. MSE). However, such a classification process, accepted in most cases, has many disadvantages and thus follows the decrease of classification precision and reliability.

Methods: The main idea of new classification process construction is based upon the application of Wavelet Neural Network (WNN), where the first layer of artificial neural network consists of feature extractor built with a help of application of Wavelet Transform (WT). This idea comes from the observation of current tendency to combain different methods or signal processing tools together and creating in such a way new possibilities, which use positive features belonging to each of particular method. In our case the wavelet layer works as an initial template feature extractor which forms the vector of numbers describing characteristics of template morphology.

After wavelet transform [Fig.1] the created vector of features describing QRS complexes mophology is transferred to the artificial neural network structure for training. We have used for training the very common back propagation algorithm. The trained neural network is able then to classify the incoming QRS complexes to the groups of extracted previously templates.