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(54) MECHANICAL ROTATING INTRAVASCULAR ULTRASONIC PROBE

ROTIERENDE MECHANISCHE INTRAVASKULÄRE ULTRASCHALLSONDE

SONDE ULTRASONORE INTRAVASCULAIRE ROTATIVE MÉCANIQUE

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Description

BACKGROUND

Technical Field

[0001] The present invention relates to the technical field of medical devices, and in particular to the technical field of intravascular ultrasound imaging devices used for interventional diagnosis and treatment.

Related Art

[0002] Intravascular ultrasound tomography (IVUS) is a novel diagnostic method combining a non-invasive ultrasonic diagnosis technology and a minimally invasive technology of interventional catheterization. As IVUS may accurately present a complex 3D anatomical structure of a blood vessel wall in real time, in addition to evaluating stenosis of lumen, it may further detect vulnerability of an atherosclerotic plaque and load of the plaque. Therefore, in the percutaneous coronary intervention treatment, IVUS has gradually replaced coronary angiography (CAG) that is originally deemed as a "gold standard" for diagnosis and treatment of a coronary heart disease, and becomes a novel diagnostic method widely applied clinically. The operation principle thereof is that, a small-sized ultrasonic transducer is installed on top of a flexible catheter about 140 cm long and about 1 mm thick, and the IVUS catheter is sent to a remote side of a target lesion location through a guide wire; during a process of pulling back the catheter (at a pullback rate of 0.5 mm/s), the ultrasonic transducer conducts 360o scanning around a blood vessel within a cavity of the blood vessel, and meanwhile, sends and receives high-frequency ultrasonic signals within the blood vessel, to implement cross-sectional imaging for each layer of the blood vessel wall, thereby assisting clinical doctors to give diagnosis for a coronary artery lesion. As a result, an intravascular ultrasound instrument includes three main components: 1) a catheter equipped with a micro ultrasonic transducer; 2) a pullback apparatus; and (3) a computerized ultrasound device with image rebuilding software and hardware. Undoubtedly, the catheter (i.e. ultrasound probe) equipped with the micro ultrasonic transducer directly operating within a narrow coronary artery is the core component that has the highest technical intensity in the entire intravascular ultrasound machine. The performance thereof directly affects quality of images and a signal-to-noise ratio, and also decides functions of system equipment and safety of use.

[0003] A commercialized intravascular ultrasound (IVUS) probe, according to structure thereof, may be roughly classified into 2 types: a mechanically rotating probe and an electronically scanned array probe. The electronically scanned array probe includes multiple (64 at most so far) array elements which are arranged in a ring shape on top of the catheter, to obtain a 360-degree cross-sectional image through sequential excitations by an electronic switch. The advantages thereof include that, neither a rotating part nor a conducting wire for connecting a single crystal is used; the guide wire passes through a central cavity thereof and easily passes through a target lesion; and it is not required to inject any liquid during use. However, there are disadvantages such as a lower image resolution and a 1-2 mm2 ultrasonic dead band easily occurring around the catheter. Although using more array elements may improve the imaging resolution, in the meantime, it will increase the volume of the probe, thus severely affecting application thereof as the intravascular probe. The mechanically rotating probe, may be further classified into 2 types, including a rotary reflector type probe (i.e. the transducer does not move but the reflector rotates) and a rotary transducer type probe, both of which are rotated (at a rate of 1,900 rpm) by a flexible driving rotary shaft within the catheter to obtain a 360-degree 2D cross-sectional image. Within a catheter of a single mechanical sector probe, gap between the transducer and a catheter sheath needs to be filled with a physiological saline solution, to achieve the best acoustic coupling. The type of mechanical sector probe, compared with the electronically scanned array probe, is advantageous in a higher imaging resolution, but the greatest disadvantage thereof is, when the catheter passes through a lesion with high-grade stenosis or a blood vessel section being curved, a friction may occur between a main shaft of the probe which is conducting rotary scanning and an inner cavity of the catheter to a great extent, thus obstructing free rotation of the catheter and causing rotation distortion to the image.

[0004] In addition, existing commercialized IVUS catheters may only help the doctors see an image of the blood vessel wall on a side of the ultrasound catheter, but fail to present an image of the blood vessel in front end thereof, such that their use is much restricted in Chronic Total Occlusion (CTO) lesions. As the most difficultly conquered problem in coronary arterial and peripheral arterial intervention treatment, CTO has a very high proportion among peripheral arterial diseases. A successful technology on blood vessel patency is the highest point of the intravascular interventional technique and CTO lesions have always constantly inspired wish of numerous clinical doctors to conquer them. The difficult problem of CTO in the medical field urgently demands research and development of forward-looking IVUS (FL-IVUS). It may be predicted that, a forward-looking IVUS catheter integrated with a radiofrequency ablation electrode may achieve visual stepwise ablation of a plaque within a partly or completely occluded blood vessel, and will provide a bright lamp for doctors performing an interventional operation, to give them the most "accurate" thoughts and therapies. Therefore, it has very broad application potential and great research significance.

[0005] Mechanically rotating ultrasound probes are known from documents US 2012/0172871 A1 and US

2002/0193690 A1.

SUMMARY

[0006] In view of disadvantages in existing intravascular ultrasound probes in the prior art, an objective of the present invention is to provide a forward-looking mechanically rotating intravascular ultrasound probe which has a small volume, a high image resolution, and good imaging stability.

[0007] In order to achieve the above objective, the present invention provides a mechanically rotating intravascular ultrasound probe, including a catheter, an ultrasonic transducer disposed at a front end of a cavity of the catheter and a driving apparatus that drives the ultrasonic transducer to rotate mechanically, where:

> the driving apparatus is a micro motor disposed in the cavity of the catheter, the micro motor comprising a rotor and a stator, and the ultrasonic transducer is fixedly installed on top of the rotor and driven to rotate by the rotor;
> the ultrasonic transducer is electrically connected to the rotor, and the rotor is also electrically connected to the stator, and electrical connections among the ultrasonic transducer, the rotor and the stator form a first channel of a signal transmission system;
> the catheter is a magnetic metal tube, and the front end of the catheter is enclosed by an acoustic window which has a spherical tip, and allows ultrasonic waves of the ultrasonic transducer to pass through; and
> the acoustic window is filled with an ionic liquid having a function of an ultrasonic coupling agent, and an electrical connection between the ionic liquid and the catheter forms a second channel of the signal transmission system.

[0008] Furthermore, the rotor is a cylinder structure having a bevel on top thereof; the ultrasonic transducer is fixedly installed on the bevel and electrically connected to the rotor; the cylinder has a spherical recess at a bottom center thereof; the stator has a spherical protrusion that matches the spherical recess; the rotor is installed on the stator and makes the spherical protrusion a fulcrum of spinning; the rotor is electrically connected to the stator through the spherical protrusion; and exterior of the micro motor is treated to achieve insulation.

[0009] Furthermore, a diameter of the catheter is 1.5-2 mm.

[0010] Furthermore, the ionic liquid having the function of the ultrasonic coupling agent is preferably 1-ethyl-3-methylimidazolium dicyanamide, 1-ethyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide or 1-butyl-3-methylimidazolium tetrafluoroborate.

[0011] Furthermore, the ultrasonic transducer is connected to the rotor in a manner that, an emitting surface of the ultrasonic waves of the ultrasonic transducer and a rotation axis of the rotor form an angle of 0-90 degrees.

[0012] Furthermore, the intravascular ultrasound probe is further provided with a rotational speed sensor for measuring a rotational position and a rotational speed of the rotor in real time.

[0013] Furthermore, exterior of the ultrasonic transducer is also provided with a metal shield at a position other than a front emitting surface of the ultrasonic waves

[0014] Furthermore, an exterior wall of the catheter is coated with a biologically compatible material.

Beneficial Effects:

[0015] Compared with the prior art, in the mechanically rotating intravascular ultrasound probe provided by the present invention, a narrow-neck micro motor is designed to be located in the catheter, which may achieve an outside diameter of the catheter between 1.5 mm and 2 mm, further reduce the volume of the probe, and solve the problem of rotation distortion of an image when the catheter passes through a lesion with high-grade stenosis or a curved blood vessel section. Additionally, by adjusting an angle of the ultrasonic transducer, the present invention achieves forward scanning imaging and side scanning imaging for a blood vessel wall. The design of the present invention is ingenious in that the ionic liquid is used as an electrical liquid brush to achieve electrical connection of the ultrasonic transducer during rotation. As the ionic liquid has a characteristic of acoustic impedance close to that of a biological tissue of a human body, it not only acts as the acoustic coupling agent, but also achieves a function of electrical conduction, thus enabling a top electrode of the ultrasonic transducer during rotation to be effectively grounded, and obtaining an electrical shielding effect. The rotor of the ultrasound probe drives the high-resolution high-frequency ultrasonic transducer to implement forward-looking conical scanning imaging for the blood vessel wall, and also utilizes the rotational speed sensor to measure the rotational position and the rotational speed of the rotor in real time, thus, in combination with a closed-loop control system, achieving accurate control over the rotational speed of the rotor as well as scanning synchronization with an imaging system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

> FIG. 1 is a structural diagram of an ultrasound probe according to one embodiment of the present invention; and
>
> FIG. 2 is a block diagram illustrating the operating principle of the ultrasound probe in FIG. 1.

[0017] In the figures:

1: catheter; 2: acoustic window; 3: micro motor; 31: rotor; 311: bevel; 312: spherical recess; 32: stator; 321: spherical protrusion; 4: high-frequency ultrasonic transducer; 5: metal shield; 6: ionic liquid.

DETAILED DESCRIPTION

[0018] The present invention will be further illustrated in detail below with reference to the accompanying drawings and specific embodiments. The following embodiments are only described for explaining the present invention, but the present invention is not limited to the following embodiments.

[0019] FIG. 1 is a structural diagram of a mechanically rotating intravascular ultrasound probe according to one embodiment of the present invention. In this embodiment, the intravascular ultrasound probe comprises a catheter 1, an acoustic window 2, a micro motor 3 and a high-frequency ultrasonic transducer 4, where the catheter 1 is a magnetic metal tube with a diameter between 1.5 mm and 2 mm, and an exterior wall thereof is coated with a biologically compatible material; the acoustic window 2, which has a spherical tip, and allows ultrasonic waves to pass through, is installed in an front end of the catheter 1 to enclose the front end of the catheter 1; the micro motor 3 is installed in a cavity of the catheter 1 and the surface thereof is treated to achieve insulation, and the micro motor 3 is composed of a rotor 31 and a stator 32, where the rotor 31 is a cylinder structure having a bevel 311 on top thereof and a spherical recess 312 at a bottom center thereof, the stator 32 has a spherical protrusion 321 that matches the spherical recess 312, the rotor 31 is disposed above the stator 32, the spherical recess 312 and the spherical protrusion 321 are engaged closely by a prestressing force, the rotor 31 spins around the spherical protrusion 321 as a fulcrum, and the rotor 31 is electrically connected to the stator 32 through the spherical protrusion 321; the high-frequency ultrasonic transducer 4 is fixedly disposed on the bevel 311 and electrically connected to the rotor 31, and exterior thereof is provided with a metal shield 5 at a position other than an front emitting surface of the ultrasonic waves; a cavity enclosed by the acoustic window 2 and the catheter 1 is filled with an ionic liquid 6, which has a function of an ultrasonic coupling agent and may be selected from 1-ethyl-3-methylimidazolium dicyanamide, 1-ethyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide or 1-butyl-3-methylimidazolium tetrafluoroborate, a top electrode of the high-frequency ultrasonic transducer 4 is electrically connected to the ionic liquid 6, and the intravascular ultrasound probe further includes a rotational speed sensor (not shown) used for measuring a rotational position and a rotational speed of the rotor 31 in real time.

[0020] The ionic liquid in the intravascular ultrasound probe not only acts as the ultrasonic coupling agent, but also utilizes a characteristic of electrical conduction thereof to achieve effective grounding of the top electrode of the high-frequency ultrasonic transducer and electrical shielding of the probe by properly arranging electrodes. The surface of the micro motor with a special shape design is treated to achieve insulation. The spherical protrusion not only acts as the fulcrum of spinning for the rotor of the micro motor, but also as an input electrode for electrical pulse signals, connecting high-voltage electrical pulses to a signal electrode of the high-frequency ultrasonic transducer through conduction of the rotor of the micro motor. Due to instability of an outside driving force plus a friction force of an interior wall of the catheter, it may often result in an unstable rotational speed of the probe. The present invention establishes a closed-loop control system, and introduces a micro rotational speed sensor embedded below the micro rotor for measuring the rotational position and the rotational speed of the rotor in real time. In combination with the closed-loop control system, the present invention achieves accurate control over the rotational speed of the rotor, as well as synchronization with an imaging system. A block diagram illustrating the operating principle of the ultrasound probe is as shown in FIG. 2.

Claims

1. A mechanically rotating intravascular ultrasound probe, comprising a catheter (1), an ultrasonic transducer (4) disposed in a cavity at a front end of the catheter (1) and a driving apparatus that is reconfigured to drive the ultrasonic transducer (4) to rotate mechanically, wherein:

the driving apparatus is a micro motor (3) disposed in the cavity of the catheter (1), the micro motor (3) comprising a rotor (31) and a stator (32), and the ultrasonic transducer (4) is fixedly installed on top of the rotor (31) to be rotated by the rotor (31);

the ultrasonic transducer (4) is electrically connected to the rotor (31), and the rotor (31) is also electrically connected to the stator (32), and wherein said electrical connections among the ultrasonic transducer (4), the rotor (31) and the stator (32) form a first channel of a signal transmission system;

the catheter (1) is a magnetic metal tube, and the front end thereof is enclosed by an acoustic window (2) which has a spherical tip that allows ultrasonic waves of the ultrasonic transducer (4) to pass through; and

the acoustic window (2) is filled with an ionic liquid (6) acting as an ultrasonic coupling agent, and wherein an electrical connection between the transducer (4), the ionic liquid (6) and the catheter (1) forms a second channel of the signal transmission system.

2. The mechanically rotating intravascular ultrasound probe according to claim 1, wherein the rotor (31) is a cylinder structure having a bevel (311) on top thereof; the ultrasonic transducer (4) is fixedly installed on the bevel (311) and electrically connected to the rotor (31); the cylinder has a spherical recess (312) at a bottom center thereof; the stator (32) has a spherical protrusion (321) that matches the spherical recess (312); the rotor (31) is installed on the stator (32) and makes the spherical protrusion (321) a fulcrum of spinning; the rotor (31) is electrically connected to the stator (32) through the spherical protrusion (321); and exterior of the micro motor (3) is treated to achieve insulation.

3. The mechanically rotating intravascular ultrasound probe according to claim 1, wherein the diameter of the catheter (1) is 1.5-2 mm.

4. The mechanically rotating intravascular ultrasound probe according to anyone of the preceding claims, wherein the ionic liquid (6) having the function of the ultrasonic coupling agent is 1-ethyl-3-methylimidazolium dicyanamide, 1-ethyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide or 1-butyl-3-methylimidazolium tetrafluoroborate.

5. The mechanically rotating intravascular ultrasound probe according to anyone of claims 1 to 3, wherein the ultrasonic transducer (4) is connected to the rotor (31) in a manner that, an emitting surface of the ultrasonic waves of the ultrasonic transducer (4) and a rotation axis of the rotor (31) form an angle of 0-90 degrees.

6. The mechanically rotating intravascular ultrasound probe according to anyone of claims 1 to 3, wherein the intravascular ultrasound probe is further provided with a rotational speed sensor for measuring a rotational position and a rotational speed of the rotor (31) in real time.

7. The mechanically rotating intravascular ultrasound probe according to anyone of claims 1 to 3, wherein the exterior of the ultrasonic transducer (4) is also provided with a metal shield (5) at a position other than a front emitting surface of the ultrasonic waves.

8. The mechanically rotating intravascular ultrasound probe according to anyone of claims 1 to 3, wherein an exterior wall of the catheter (1) is coated with a biologically compatible material.

Patentansprüche

1. Mechanisch rotierende intravaskuläre Ultraschallsonde, umfassend einen Katheter (1), einen Ultraschallwandler (4), angeordnet in einem Hohlraum an einem vorderen Ende des Katheters (1), und eine Antriebsvorrichtung, die dafür konfiguriert ist, den Ultraschallwandler (4) zum mechanischen Rotieren anzutreiben (4), wobei:

   die Antriebsvorrichtung ein Mikromotor (3) ist, angeordnet im Hohlraum des Katheters (1), wobei der Mikromotor (3) einen Rotor (31) und einen Stator (32) umfasst und der Ultraschallwandler (4) oben auf dem Rotor (31) fest installiert ist, um durch den Rotor (31) rotiert zu werden;
   der Ultraschallwandler (4) elektrisch mit dem Rotor (31) verbunden ist und der Rotor (31) auch elektrisch mit dem Stator (32) verbunden ist und wobei die elektrischen Verbindungen zwischen dem Ultraschallwandler (4), dem Rotor (31) und dem Stator (32) einen ersten Kanal eines Signalübertragungssystems bilden;
   der Katheter (1) ein magnetisches Metallrohr ist, dessen vorderes Ende durch ein Schallfenster (2) umschlossen ist, das eine Kugelspitze aufweist, die Ultraschallwellen des Ultraschallwandlers (4) einen Durchlass ermöglichen; und das Schallfenster (2) mit einer Ionenflüssigkeit (6) gefüllt ist, die als Ultraschall-Koppelungsmittel wirkt, und wobei eine elektrische Verbindung zwischen dem Wandler (4), der Ionenflüssigkeit (6) und dem Katheter (1) einen zweiten Kanal des Signalübertragungssystems bildet.

2. Mechanisch rotierende intravaskuläre Ultraschallsonde nach Anspruch 1, wobei der Rotor (31) eine Zylinderstruktur mit einer Abschrägung (311) an ihrer Oberseite ist, der Ultraschallwandler (4) auf der Abschrägung (311) fest installiert und elektrisch mit dem Rotor (31) verbunden ist, der Zylinder eine ballige Vertiefung (312) in seiner unteren Mitte aufweist, der Stator (32) einen der balligen Vertiefung (312) entsprechenden balligen Vorsprung (321) aufweist, der Rotor (31) auf dem Stator (32) installiert ist und den balligen Vorsprung (321) zum einem Drehpunkt der Rotation macht, der Rotor (31) durch den balligen Vorsprung (321) elektrisch mit dem Stator (32) verbunden ist und das Äußere des Mikromotors (3) behandelt ist, um eine Isolierung zu erreichen.

3. Mechanisch rotierende intravaskuläre Ultraschallsonde nach Anspruch 1, wobei der Durchmesser des Katheters (1) 1,5 bis 2 mm beträgt.

4. Mechanisch rotierende intravaskuläre Ultraschallsonde nach einem der vorhergehenden Ansprüche, wobei die Ionenflüssigkeit (6) mit der Funktion des Ultraschall-Koppelungsmittels 1-Ethyl-3-Methylimidazoliumdicyanamid, 1-Ethyl-3-Methylimidazolium-bis(trifluormethylsulfonyl)imid oder 1-Butyl-3-Me-

thylimidazoliumtetrafluorborat ist.

5. Mechanisch rotierende intravaskuläre Ultraschallsonde nach einem der Ansprüche 1 bis 3, wobei der Ultraschallwandler (4) mit dem Rotor (31) derart verbunden ist, dass eine Ultraschall-Emittierungsoberfläche des Ultraschallwandlers (4) und eine Rotationsachse des Rotors (31) einen Winkel von 0 bis 90 Grad bilden.

6. Mechanisch rotierende intravaskuläre Ultraschallsonde nach einem der Ansprüche 1 bis 3, wobei die intravaskuläre Ultraschallsonde ferner mit einem Rotationsgeschwindigkeitssensor versehen ist, um eine Rotationsposition und eine Rotationsgeschwindigkeit des Rotors (31) in Echtzeit zu messen.

7. Mechanisch rotierende intravaskuläre Ultraschallsonde nach einem der Ansprüche 1 bis 3, wobei das Äußere des Ultraschallwandlers (4) an einer anderen Stelle als einer vorderen Ultraschall-Emittierungsoberfläche auch mit einer Metallabschirmung (5) versehen ist.

8. Mechanisch rotierende intravaskuläre Ultraschallsonde nach einem der Ansprüche 1 bis 3, wobei eine Außenwand des Katheters (1) mit einem biologisch kompatiblen Material beschichtet ist.

Revendications

1. Sonde à ultrasons intravasculaire mécaniquement rotative, comprenant un cathéter (1), un transducteur à ultrasons (4) disposé dans une cavité à l'extrémité avant du cathéter (1) et un dispositif d'entraînement conçu pour entraîner le transducteur à ultrasons (4) pour le faire tourner mécaniquement, où :

   le dispositif d'entraînement est un micromoteur (3) disposé dans une cavité du cathéter (1), le micromoteur (3) comprenant un rotor (31) et un stator (32), et le transducteur à ultrasons (4) est installé fixement au sommet du rotor (31) pour être mis en rotation par le rotor (31) ;
   le transducteur à ultrasons (4) est connecté électriquement au rotor (31), et le rotor (31) est également connecté électriquement au stator (32), lesdites connexions électriques entre le transducteur à ultrasons (4), le rotor (31) et le stator (32) formant un premier canal du système de transmission de signaux ;
   le cathéter (1) est un tube de métal magnétique, et son extrémité avant est incluse dans une fenêtre acoustique (2) comportant une pointe sphérique qui permet de traverser à des ondes ultrasoniques du transducteur à ultrasons (4) ; et
   la fenêtre acoustique (2) est remplie d'un liquide ionique (6) agissant comme agent de couplage ultrasonique,
   et où une connexion électrique entre le transducteur (4), le liquide ionique (6) et le cathéter (1) forme un deuxième canal du système de transmission de signaux.

2. Sonde à ultrasons intravasculaire mécaniquement rotative selon la revendication 1, dans laquelle le rotor (31) est une structure cylindrique comportant un chanfrein (311) à son sommet ; le transducteur à ultrasons (4) est installé de façon fixe sur le chanfrein (311) et est connecté électriquement au rotor (31) ; le cylindre comporte un renfoncement sphérique (312) en bas au centre ; le stator (32) comporte une protubérance sphérique (321) qui correspond au renfoncement sphérique (312) ; le rotor (31) est installé sur le stator (32) et fait de la protubérance sphérique (321) un pivot de rotation ; le rotor (31) est électriquement connecté au stator (32) à travers la protubérance sphérique (321) ; et l'extérieur du micromoteur (3) est traité pour assurer une isolation.

3. Sonde à ultrasons intravasculaire mécaniquement rotative selon la revendication 1, dans laquelle le diamètre du cathéter (1) est de 1,5 à 2 mm.

4. Sonde à ultrasons intravasculaire mécaniquement rotative selon l'une quelconque des revendications précédentes, dans laquelle le liquide ionique (6) ayant fonction d'agent de couplage ultrasonique est le dicyanamidure de 1-éthyl-3-méthylimidazolium, le bis-(trifluorométhylsulfonyl)imidure de 1-éthyl-3-méthylimidazolium ou le tétrafluoroborate de 1-butyl-3-méthylimidazolium.

5. Sonde à ultrasons intravasculaire mécaniquement rotative selon l'une quelconque des revendications 1 à 3, dans laquelle le transducteur à ultrasons (4) est connecté au rotor (31) de telle manière qu'une surface émettrice d'ondes ultrasoniques du transducteur à ultrasons (4) et un axe de rotation du rotor (31) forment un angle entre 0 et 90°.

6. Sonde à ultrasons intravasculaire mécaniquement rotative selon l'une quelconque des revendications 1 à 3, la sonde à ultrasons intravasculaire étant pourvue en outre d'un capteur de vitesse de rotation destiné à mesurer une position de rotation et une vitesse de rotation du rotor (31) en temps réel.

7. Sonde à ultrasons intravasculaire mécaniquement rotative selon l'une quelconque des revendications 1 à 3, dans laquelle l'extérieur du transducteur à ultrasons (4) est également pourvu d'un bouclier métallique (5) à une position autre qu'une surface avant émettrice des ondes ultrasoniques.

8. Sonde à ultrasons intravasculaire mécaniquement rotative selon l'une quelconque des revendications 1 à 3, dans laquelle une paroi externe du cathéter (1) et recouverte d'un matériau biologiquement compatible.

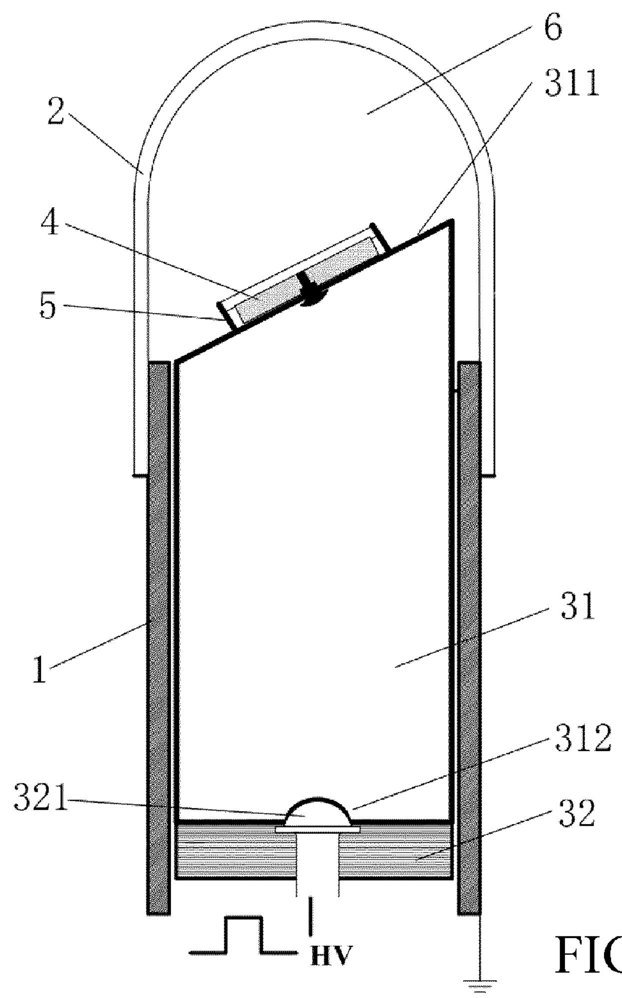
6
311
2
4
5
31
1
312
321
32
HV

FIG. 1

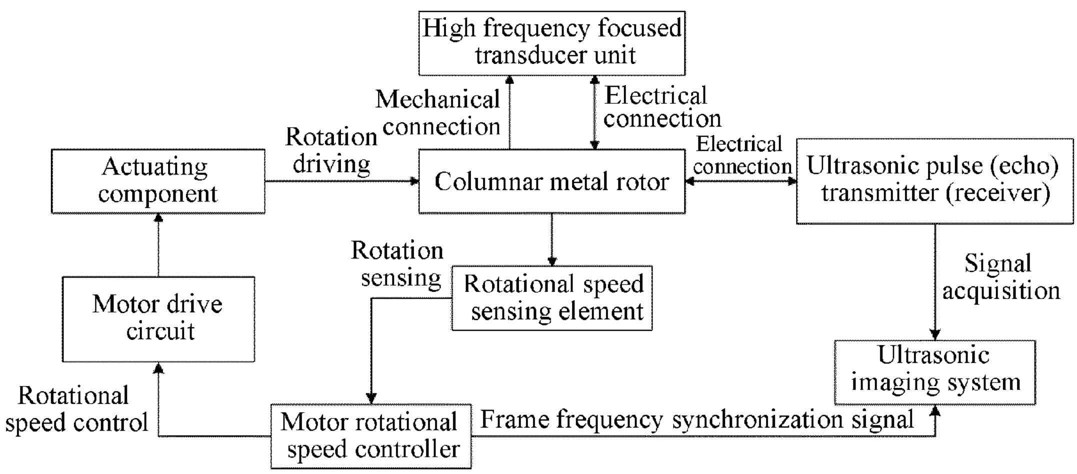
High frequency focused transducer unit
Mechanical connection
Electrical connection
Rotation driving
Actuating component
Columnar metal rotor
Electrical connection
Ultrasonic pulse (echo) transmitter (receiver)
Rotation sensing
Rotational speed sensing element
Signal acquisition
Motor drive circuit
Ultrasonic imaging system
Rotational speed control
Motor rotational speed controller
Frame frequency synchronization signal

FIG. 2

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

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外部链接	Espacenet		

摘要(译)

机械旋转血管内超声探头涉及医疗设备的技术领域，旨在提供一种体积小，图像分辨率高，成像稳定性好的前视机械旋转血管内超声探头。血管内超声探头包括导管（1），设置在导管（1）的腔的前端的超声换能器（4）和驱动超声换能器（4）机械旋转的驱动装置。驱动装置是设置在导管（1）的腔中的微电机（3），包括转子（31）和定子（32）。超声波换能器（4）安装在转子（31）的顶部并电连接到转子（31），转子（31）也电连接到定子（32）;导管（1）是磁性金属管，其前端由声窗（2）包围，声窗（2）具有球形尖端并允许超声换能器（4）的超声波通过;声窗（2）填充有具有超声耦合剂功能的离子液体。当导管（1）穿过具有高度狭窄的病变或弯曲的血管部分时，超声探头解决了图像旋转扭转的问题，并实现了血管壁的正向扫描成像和侧扫描成像。

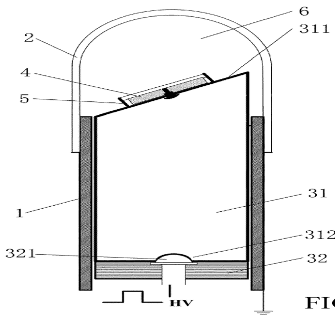

FIG. 1

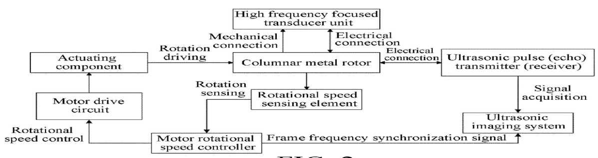

FIG. 2