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A PATH FOR HORIZING YOUR INNOVATIVE WORK

INDUCTIVE CHARGING FOR AUTONOMOUS VERTICAL PROFILER FOR LONG TERM DEPLOYMENT FOR NIO AT TILLARI DAM

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Abstract- Inductive charging is the transfer of electrical energy without using any conductor or wire. It is useful to transfer electrical energy to those places where it is hard to transmit energy using conventional wires. In this paper, we designed a prototype circuit for wireless power transfer using the square wave generated high frequency alternating supply and magnetic resonant coupling to charge battery inductively. Tables are drawn to show the comparison of voltage received with distance on receiver side of a coils. Underwater inductive coupling is used to recharge a lithium-polymer battery for an underwater mooring profiler operating on a cabled deep-ocean mooring sensor network. The mooring profiler is a motor driven autonomous vertical profiler that is attached to a vertical mooring cable suspended between the seafloor and subsurface float structure.The on-board batteries are charged inductively when the profiler enters into charging station.

Keywords:- Autonomous Vertical Profiler, Inductive Charging, Magnetic resonant coupling, Arduino Uno .

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INTRODUCTION

Autonomous vertical profiler (AVP) designed and developed at National Institute of Oceanography (NIO) , Goa for use in both coastal and freshwater bodies. The Autonomous vertical profiler (AVP) was used in experiments to satellite transmit complete time and location referenced high resolution profiles of temperature , phytoplankton concentration, turbidity and DO from the remote Tillari Dam and other freshwater reservoirs. The AVP is a robot profiler that is propelled downwords through the water column by a DC thruster while sensing and storing the vertical structure of water properties as a function of depth. The profiler can be programmed to descend to a given depth set by the user,while its ascent to the surface is without propulsion , as it is positively buoyant on breaking the sea surface the AVP transmits its Global positioning system (GPS) coordinates , measured sensor data and vehicle parameters via a satellite modem . A time series of repeat dives at a fixed location and at set intervals can be built up to monitor temporal changes in the ecosystem variables through the day and night over several days.

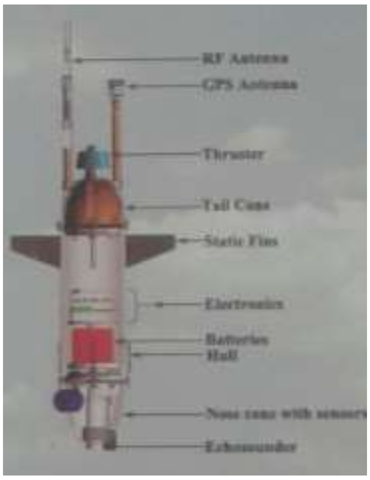
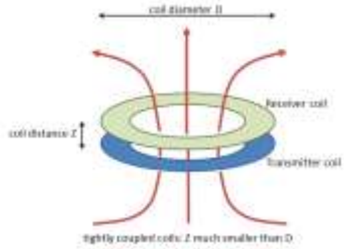


Fig1: Autonomous Vertical Profiler (AVP)

Inductive power transfer works by creating an alternating magnetic field (flux) in a transmitter coil and converting that flux into an electrical current in the receiver coil. Depending on the distance between the transmit and receive coils, only a fraction of the magnetic flux generated by the transmitter coil penetrates the receiver coil and contributes to the power transmission. The more flux reaches the receiver, the better the coils are coupled.

The transmit and receive coils are tightly coupled when (a) the coils have the same size, and (b) the distance between the coils is much less than the diameter of the coils.



Wireless power transmission (WPT) is an efficient way for the transmission of electric power from one point to another through vacuum or atmosphere without the use of wire or any substance. By using WPT, power can be transmitted using inductive coupling for short range, resonant induction for mid-range and Electromagnetic wave power transfer. By using this technology, it is possible to supply power to places, which is hard to dousing conventional wires. Currently, the use of inductivecoupling is in development and research phases. The most common wireless power transfer technologies are the electromagnetic induction and the microwave power transfer. For efficient midrange power transfer, the wireless power transfer system must satisfy three conditions: (a) high efficiency, (b) large air gap, (c) high power. The microwave power transfer has a low efficiency, For near field power transfer this method may be inefficient, since it involves radiation of electromagnetic waves.

Electromagnetic induction method has short range. Since magnetic field coupling power transfer method has higher efficiency. However in our project high frequency is generated from Arduino Uno which is given to NPN transistorBC547B which drives or switches P channel and N channel Mosfet with resistors connected at gate of mosfets which generates square wave ac signal which is given Transmitter coil to generate alternating magnetic field .

ADVANTAGES

[1] Lower Frequency Operation – The operating frequency range is in the kilohertz range. This attribute makes it easy to experiment and test in breadboard. Furthermore there is low risk of radiation in the LF band.

[2] Even mobile transmitters and receivers can be chosen for the wireless power transfer system. The power could be transmitted to the places where the wired transmission is not possible.

[3] Loss of transmission is negligible level in the Wireless Power Transmission; therefore, the efficiency of this method is very much higher than the wired transmission. The cost of transmission and distribution become less. Cost of electrical energy for the consumer also would be reduced.

DISADVANTAGES

[1] It has complex circuitry therefore proven to be difficult to implement and is not efficient over a long distance.

[2] Practical for Short Distance – The designed system is very practical for short distance as long as the coupling coefficient is optimized.

II. WORKING METHODOLOGY

Block Diagram showing Transmitter and Receiver section

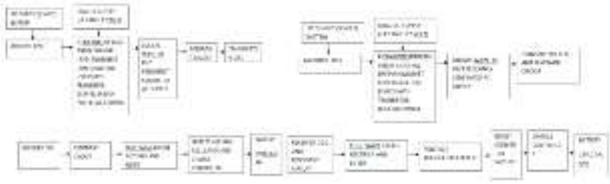


Fig :2.1

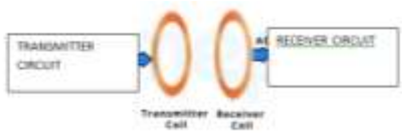


Fig 2.shows Complete block diagram of Inductive charging

Squarewave pulses of kHz frequency range generated ac signal from P channel and N channel mosfet is given to Transmitter coil an alternating voltage is induced in the Receiver coil of the Inductive coupling. The voltage thus obtained at the secondary is rectified and regulated and charge controller is used to charge the battery.

MAGNETIC RESONANT COUPLING

Magnetic Resonant coupling uses the same principles as inductive coupling, but it uses resonance to increase the range at which the energy transfer can efficiently take place. Resonance can be two types: (a) series resonance & (b) parallel resonance. In these both types of resonance the principle which is to get maximum energy transfer.

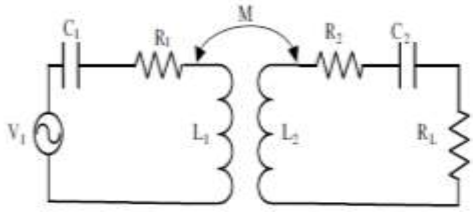


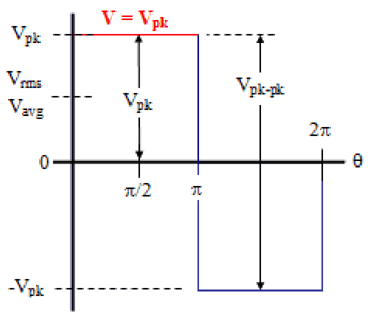
Fig 3.Resonant Wireless Power Transmission Circuit Diagram

Figure above shows how the resonance occurs. Here the circuit-1 is called primary circuit and the circuit-2 is called secondary circuit. The energy transfer will occur between these two circuits. The resonant conditions in such circuit either in the primary circuit, when the primary current is in phase with the input voltage, or in the secondary circuit, when the secondary circuit current is in phase with the secondary induced voltage. The former resonance is called primary particular resonance and the latter is a secondary particular resonance. The full resonance occurs when both the primary and the secondary circuits are in the resonant condition. Resonant transfer works by making a coil ring with an oscillating current. This generates an oscillating magnetic field. Because the coil is highly resonant and any amount of energy placed in the coil dies away relatively slowly over time periods. However, if a second coil is brought near to it, the coil can pick up most of the energy before it is lost. The resonant frequency can be calculated from the equivalent circuit.
Resonant frequency is given as

$$F_R = \frac{1}{2\pi\sqrt{LC}}$$

At Resonance condition
XL=XC
XL=2 πFL
XC=1/2 πFC

Square waveform to generate alternating signal(AC) to inductive coil.
Vrms is calculated by taking the square root of the mean average of the square of the voltage in an appropriately chosen interval.



Vrms=Vp

Fig 4.High Frequency AC Square waveinput to transmitter

IV.WIRELESS POWER TRANSFER ANALYSIS

1. Experimental components used

ARDUINO UNO FEATURES

MICROCONTROLLER	ATMEGA 328P
OPERATING VOLTAGE	5 V
INPUT VOLTAGE (RECOMMENDED)	7-12V
INPUT VOLTAGE (LIMIT)	6-20 V
DIGITAL INPUT –OUTPUT PINS	14 OF WHICH 6 PINS ARE FOR PWM
PWM DIGITAL INPUT- OUTPUT PIN	6
ANALOG INPUT PINS	6
DC CURRENT PER INPUT – OUTPUT PIN	20mA
DC CURRENT FOR 3.3 V PIN	50mA
FLASH MEMORY	32KB (ATMEGA 328P) OF WHICH 0.5 KB BY BOOTLANDER
SRAM	2 KB

EEPROM	1 KB
CLOCK SPEED	16MHZ
LENGTH	68.6 mm
WIDTH	53.4mm
WEIGHT	25 G

COMPONENTS TABLE

COMPONENT	TYPE
ARDUINO UNO	ATMEGA 328P
TRANSISTERAS A DRIVER	BC547B,2N3904
MOSFET DRIVER	IR2111,LM2722,IR2110
N-CHANNEL MOSFETS	IRFZ44N,IRF540
P -CHANNEL MOSFETS	IRF9630,IRF9530
BREADBOARD AND REGISTERS	1NO
DUAL DC POWER SUPPLY	2 NO
CAPACITORS	100uf,
COPPER WIRE	24SWG, 22SWG
MULTIMETERS	1 NO
DIODES AND VOLTAGE REGULATOR IC,CHARGE CONTROLLER	BA159,LM317T, LM7805,LM7812
BATTERY	5V,12V,0.5A, 9AH
SIMULATION SOFTWARE	MULTISIM ,PSIM
DC SUPPLY FROM BATTERY	9V

V.PERFORMCE ANALYSIS

Experimental Results

INPUT AC VOLTAGE=12VOLTS AND

FREQUENCY=31 KHZ

DIAMETER OF COIL=6CM

NO OF TURNS		RECEIVED VOLTAGE (AC) BY RECEIVER COIL AT DIFFERENT DISTANCE			
TRANSMITTER COIL	RECEIVER COIL	DISTANCE 1 CM	DISTANCE 2CM	DISTANCE 3 CM	DISTANCE 4 CM
50	50	0.5V	0.41V	0.37V	0.1V
50	100	0.9V	0.42V	0.22V	0.12V
100	100	0.93V	0.45V	0.25V	0.13V
100	200	1.15V	1.1V	0.33V	0.21V
50	200	2.97V	1.91V	0.58V	0.27V
50	400	4.52V	3.82V	1.82V	0.91V
100	400	3.87V	2.48V	1.78V	0.73V

INPUT AC VOLTAGE=12VOLTS ,

FREQUENCY=31 KHZ

DIAMETER OF COIL=10 CM

NO OF TURNS		RECEIVED VOLTAGE (AC) BY RECEIVER COIL AT DIFFERENT DISTANCE					
TRANSMITTER COIL	RECEIVER COIL	DISTANCE 1 CM	DISTANCE 2 CM	DISTANCE 3CM	DISTANCE 4 CM	DISTANCE 5 CM	DISTANCE 7 CM
50	200	5.73V	4.89V	3.89V	2.17V	2V	0.82V
50	300	9V	6.92V	6.10V	5.79V	4.83V	1V
100	200	5.89V	4.21V	3.63V	3.42V	3.17V	0.87V

Efficiency (η) = (Pout/Pin) * 100
We used the following formula for power calculation P = VI

Fig5 . Square wave generated high frequency AC signal to coil

Fig6 .complete Setup with coils

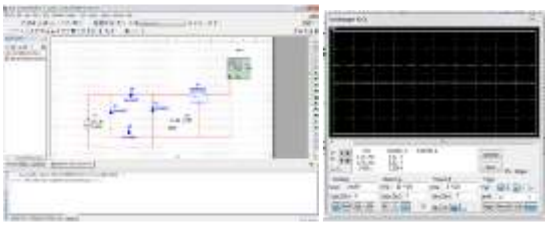


Fig 7 shows Simulation Output on Receiver side to charge the 5V battery using Multisim software

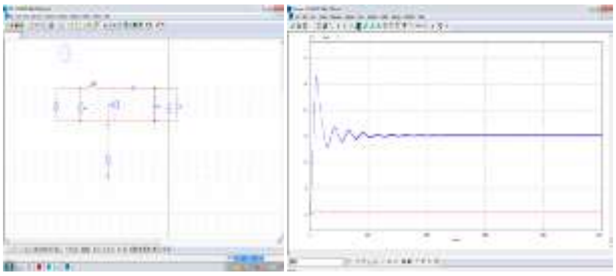


Fig 8.shows Simulation Output of boost converter on Receiver side to charge the 12V battery using Psim software

VI. APPLICATION OF INDUCTIVE CHARGING

There are some industrial applications such as Direct wireless power and communication interconnections across rotating and moving joints (robots, packaging machinery, assembly machinery, machine tools) eliminating costly and failure-prone wiring. Wireless electricity is a recently developed application of inductive charging. It has been demonstrated that it is feasible to transmit a significant amount of power at a high efficiency.

VII. CONCLUSION

The goal of this project was to design and implement a Inductive power transfer system to charge battery via magnetic resonant coupling.

A system was designed and implemented. Experimental results showed that significant improvements in terms of power-transfer efficiency have been achieved. The output voltage obtained with various turns ratio have been tabulated above.

Since the ratio of 50:300 at Resonance condition gave the maximum transfer voltage that turns ratio was chosen for employing in the transmitter and the receiver coils. The coils were hand wound with 6 cm and 10cm diameter using 24 and 22 standard wire gauge. Measured results are in good agreement with the theoretical calculations.

We have described and demonstrated that magnetic resonant coupling can be used to deliver power wirelessly from a transmitter coil to a with a receiver coil with air core. coil placed between the source and load coil and with capacitors at the coil terminals providing a sample means to match resonant frequencies for the coils. This mechanism isa potentially robust means for delivering wireless power to a receiver from a source coil.

VIII.FUTURE WORK

The circuit was just trial representation of wireless charging concept. As it was very difficult to transfer power wirelessly between two coils over a distance .Now to increase power transfer need to try with more number of turns on both transmitter and receiver side to check power transfer difference. After this ac power will be rectified and rectified output will be given to voltage regulator LM317T and charge controller will charge 5V battery and after that 5V using voltage regulator ICLM317Tand 5Vwill be boosted to 15V using boost converter and then by using charge controller will charge12V battery.

REFERENCES

1. Inductive Power Transfer by By Grant A. Covic, Senior Member IEEE, and John T. Boys IEEE | Vol. 101, No. 6, June 2013

2. Modern Trends in Inductive Power Transfer for Transportation Applications by Grant Anthony Covic, *Senior Member, IEEE*, and John Talbot Boys IEEE Journal of emerging and selected topics in power electronics, vol. 1, no. 1, March 2013.

3. N. Tesla, U.S. Patent 1,119,732 (1914)

4. Understanding our seas :National Institute of Oceanography , Gos by S.W.A.Naqvi and CSIR-NIO Team dona Paula , Goa

5. Zia A. Yamayee and Juan L. Bala, Jr., "Electromechanical Energy Devices and Power Systems", John Wiley and Sons,1947, p. 78.

6. Simon Ramo, John R. WhinneryandTheodore Van Duzer,"Fields and Waves in Communication Electronics", John Wiley & Sons, Inc.; 3rd edition (February 9, 1994).

7. E. Abel and S. Third, ''Contactlesspower transfer-An exercise I topology,''IEEETrans.Magn., vol. MAG 20, no 5, pp. 1813–1815, Sep.–Nov. 1984.

8. P. Sergeant and A. Van den Bossche, ''Inductive transmission'' IET Electr. Power Appl., vol. 2, coupler for contactless power pp. 1–7, 2008.

9. IEEE Paper: Multi-Frequency Inductive Power Transfer as a means to decouple Multi-Coil Primary and Secondary Topologies Authors: Jose RalinoPrazeres, VenugopalPrasanth, Pavol Bauer.

10. Website: en.wikipedia.org/wiki/Wireless power

11. Website:en.wikipedia.org/wiki/Resonant_inductiveCoupling.

12. BasharatNizam, K L University "Inductive Charging Technique", International Journal of Engineering Trends and Technology (IJETT), Volume4, Issue4, April 2013, ISSN: 2231-5381 http://www.ijettjournal.org pp1054-1059.

13. N. Tesla, "Apparatus for transmission of electrical energy,"U.S. Patent 649,621, dated May 15, 1900.

14. Wireless Power Transfer through Inductive Coupling by Mohamed A. Hassan, A.Elzawawi page 115-118

15. Andre Kurs, AristeidisKaralis, Robert Moffatt, J. D. Joannopoulos, Peter Fisher, Marin Soljacic, "Wireless Power Transfer via Strongly Coupled Magnetic Resonances," in Science Express on 7 June 2007, Vol. 317. no. 5834, pp. 83 - 86.