

X-Ray Machine Radiation Protection using RF Module

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Abstract: This paper presents the design of a wireless hand switch of X-Ray machine using RF Module. With the objective to avoid unnecessary exposure of radiation, a low cost RF Module is proposed. This method uses RF transmitter and RF receiver modules which are operating at 434 MHz along with encoder IC M145026 and decoder M145027 with the passive components. Here the transmission technique is amplitude shift keying (ASK) and the circuit is powered with 5v. A RF module based wireless hand switch commands the receiver for ready and exposure through transmitter wirelessly. There are two benefits from the design.

- a) It can save the repetition of exposure when there are movements in patients especially for children, older and injured patients.
- b) It can be operated from computed radiography room that can avoid exposure of x-ray radiation for the operator.

Keywords: X-Ray Machine, Radiation, Radiation Protection, Hand Switch, RF Module

I. INTRODUCTION

An x-ray machine is any machine that involves x-rays. It produces a controlled beam of radiation, which is used to create an image of the inside of the body. This beam is directed at the area being examined. After passing through the body, the beam falls on a piece of film or a special plate where it casts a type of shadow. Different tissues in the body block or absorb the radiation differently. Dense tissue such as bones blocks most of the radiation and appears white on the film. Soft tissues such as muscles block less radiation and appear darker on the film. The air in the lungs shows up as black. Often multiple images are taken from different angles so a more complete view of the area is available. The images obtained during x-ray exams may be viewed on film or put through a process called digitizing so that they can be viewed on a computer screen [1].

But there are adverse effects from its radiation. Radiation is a phenomenon present in our daily lives, originating from natural and man-made sources. Living organizations are potentially affected by radiation- induced cellular damage, threatening healthy and diseases tissues alike. There is a wide range of response to radiation, which is determined by parameters, including the radiation sources, radiation dosage, and length of exposure and importantly, the genetic and epigenetic makeup of the exposed individual. These parameters can range widely and humans may be exposed to low dose of radiation are high dose of radiation [2, 3]. Radiation is classified into two major forms: Ionizing and non-ionizing [4, 5]. X-rays are forms of ionizing radiation that enough energy to potentially cause damage to DNA. A small increase in the possibility that a person exposed to x-rays will develop cancer later in life. Tissue effects such as cataract, skin reddening and hair loss which occur at relatively high levels of radiation exposure. Radiation protection is almost as old as the invisible rays discovered by Wilhelm Roentgen on 8 November 1895. The damaging effects of x-rays were discovered shortly afterwards. The protection of people from effects of exposure to ionizing radiation is known as Radiation protection [6].

Fundamental to radiation protection is the avoidance or reduction of dose using the simple protective measure of time, distance and shielding. The duration of exposure should be limited to that necessary; the distance from the source of radiation should be maximized, and the source shielded wherever possible. The radiation protection action related to the distance between the source of radiation and the exposed individual when the exposure to the individual decreases inversely as the square of the distance. This is known as the inverse square law. Where I, is the intensity of radiation and d is the distance between the radiation source and the exposed individual. For example, where the distance is doubled the exposure is reduced by a factor of four. [7]. To restrict the radiation exposure of individual persons, and the overall population, work and contact with ionizing radiation is regulated by recommendations, directives, ordinances and laws. The use of ionizing radiation is regulated by legislative bodies to limits both individuals and the population exposure to radiation. From a radiological protection perspective, clear justification for radiological examinations and techniques aimed at minimizing radiation dose while providing the required information, are essential. Referring doctors should be sure to use existing guidelines for medical imaging and liaise with radiologists & nuclear medicine specialist, with whom they share the responsibilities for choosing appropriate imaging modalities [6].

II. DESIGN OF WIRELESS X-RAY HAND SWITCH USING RF MODULE

The idea of designing of wireless x-ray hand switch came into mind while working in a manufacturing company of x-ray machine as service profile. Then I started reading on subjects related to the x-ray machine for the protection against radiation. D.Suo, Y.Ham and G.Yang proposed for wireless remote control system basically could meet the request for long distance control and image transfers in the different field [6]. This renovated system guided me in the right direction to make wireless x-ray hand switch. Here we discuss wireless communication using RF module and interaction RF with 8051 microcontroller, which when interfaced with 8051 microcontroller provides us with various controlled operations. A wireless radio frequency (RF) transmitter and receiver can be easily made using M145027 decoder, M145026 encoder and ASK RF module. Wireless transmission can be done by using 434Mhz ASK RF transmitter and receiver modules. In this module digital data is represented by different amplitude of the carrier wave, hence this modulation is known as Amplitude shift keying (ASK). Radio Frequency (RF) transmission is more protective and reliable than wire hand switch against ionizing radiation. Radio frequency signals travel longer distances. These signals can be transmitted even when there are obstacles so the benefit is that it can be used inside the computed radiography room. Signals on one frequency band in RF will not interfere by other frequency RF signals.

Schematic diagram of RF module

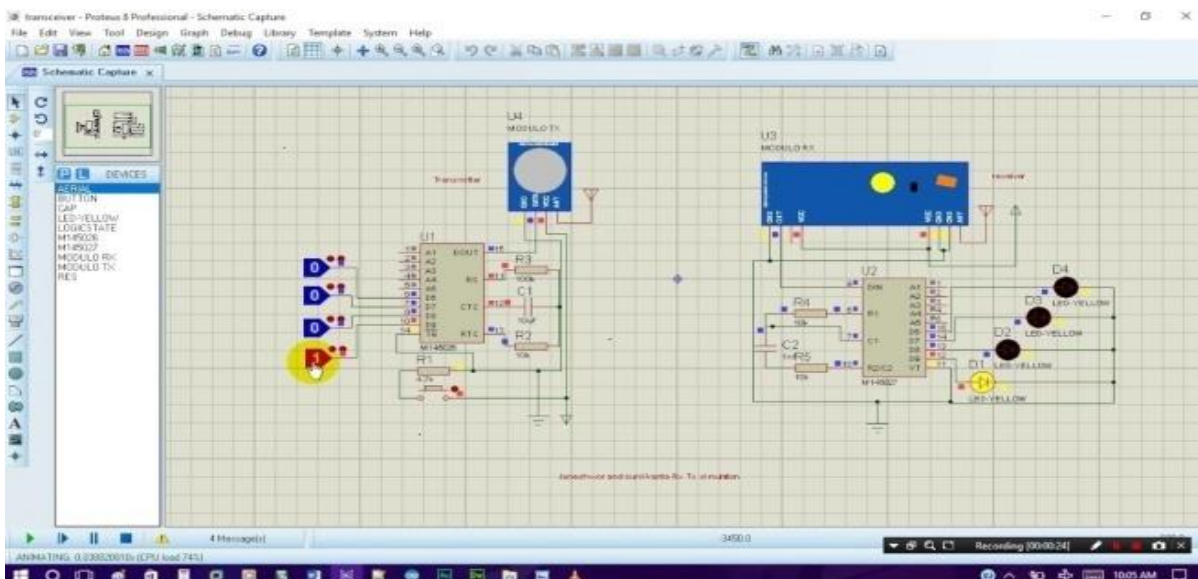


Figure: Circuit diagram of RF module

III. CIRCUIT DESIGN OF RF MODULE

Circuit design of RF module

The schematic circuit is shown is design on the Proteus suite. The Proteus design suite is a proprietary software tool suite used primarily for electronic design automation. Here the software is used mainly for designing of wireless RF module. It is a window application for schematic capture, simulation and PCB layout design. It is used for both simulation operations and as the design phase of the PCB layout project. For the designing of above circuit, it requires Transmitter module, Receiver module, M145026 encoder, M145027 decoder and passive components. The first pin of the transmitter module is connected to the antenna which is of a simple wire of 10 meters that works as an antenna. Module and IC work on 5v so provide 5v supply. Pin 15 of the IC is connected to the data pin of the transmitter module. There are four input pins D6, D7, D8 and D9 that are connected to the logic state as shown in the diagram. TE is the 14 pins for active low. Pins RS, CTC, RTC are connected to the resistors for oscillations. The designing of the circuit completes the transmitter module. The second is of receiver module. There are two Vcc and two grounds of Receiver module. So Vcc is connected to the 5v supply and ground is connected to the ground. Antenna is connected to a wire of 10m. The output pins D6 to D9 are connected to the LED. R1, C1 and R2, C2 are connected for indication and detector simultaneously. VT is for valid transmission. The circuit completes its design as shown above in the diagram.

Working of RF modules

During the working process of the circuit, when input D9 is pressed, then D1 led will glow. When input D8 is pressed then D2 led will glow. Simultaneously it works the same while pressing the input pins. When two inputs are pressed then two led will glow. And when all are pressed all will glow. It works when the transmitter signals send the signal to the receiver. It works without any delay wirelessly.

IV. APPLICATION OF RF MODULE IN DESIGNING OF WIRELESS HAND SWITCH

Now with the help of above circuits diagram and its working, we can apply the same RF circuit to the x-ray machine. There are two cards: one is the transmitter and other is the receiver. The exposure cord (hand switch) will be connected to the transmitter as an input. The exposure cord (hand switch) is given to the operator for x-ray exposure that can be operated at any distance wirelessly. The receiver is placed inside the x-ray machine which is connected to the circuit of x-ray machine. The outputs of the receiver are connected to the relay. The relay is then connected to the x-ray tube that works according to the signals receive. There are four inputs shown above but here for this application we use only two pins as an input. One input is for Ready and the two inputs for (Ready and Exposure) when pressing the two inputs at the same time. The operator pressed the exposure cord and the transmitter sends the signals to the receiver. The receiver received the signal without delay. The receiver then supplies the electrical current to relay. The relay gets connected and electrical current supplied to the x-ray tube. X-ray tube is responsible for the emission of x-ray which is taken on films or cassettes to take the images. So, this circuit is very easy to design and is very helpful for the operator to prevent against ionizing radiation. The proposed designing of the circuit is very easy to design as well economical.

V. RESULTS AND SIMULATION

Results

The RF module based wireless hand switch for the operation of (Ready and Exposure) of the x-ray tube has been designed and the model version built. Each and every part of the system has been assembled and tested on software based Proteus suite successfully. The led that are connected to the receiver as an output glow while pressing the input key that is connected to the transmitter. When one input key is pressed at the transmitter end then one led will glow as an output which is wireless that is connected to the receiver. When all keys are pressed then all led will glow as an output. The operator operates the transmitter from any place. It is from the long distance of 60 feet or the shorter distance. There is no effects on its performance while operation. The transmitter sends the signals to the receiver without delay. On the basis of this result, the same circuit may be applied to x-ray machine for taking images on films or cassettes in digital mode.

Simulation of the model

After pressing a button of transmitter, the transmitter starts to deliver signals and then the receiver started to receive the signals without any delay. 434 Mhz transmitter has been used with consists of four keys or buttons which work for four different parts of the whole process as shown in the schematic diagram. For the prospect of the work a same range of receiver and transmitter has been used for the whole system. Through this wireless hand switch (transmitter) users can transfer signals for (Ready and Exposure) for the operation the x-ray machine. After completing the simulation and viewing the results it is obvious to see that the simulation of the proposed system achieves the desired goals. The operator operates the x-ray machine from wireless hand switch efficiently from anywhere as his desires and as it increases the distance then it is obviously protect against the harmful ionizing radiation. It also saves the repetition of the x-ray exposure.

VI. CONCLUSION

This research work has been carried out for designing a wireless x-ray hand switch using RF module. This article gives an overview of wireless x-ray hand switch using RF module to protect against the ionizing radiation for operator of an x-ray machine. The characteristics and hence the performance of the RF module have revealed that is very useful in the field of wireless applications. It has also been found that a vast research is going on this field, which definitely is going to be very productive in the near future. The analysis methodology has been found to be very helpful for design the proposed wireless hand switch using RF module. A wireless hand switch based RF module which resonates at 434 Mhz. In addition M145026 encoder and M145027 decoder have been added for coding and decoding for wireless applications. The design of the hand switch using RF module has been effective as compared to the conventional x-ray machine. The results have shown that is applicable for the wireless and useful to protect against radiation.

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