Auto-Identification in Dentistry: A Detailed Analysis and the Literature Review of Radio Frequency Identification Technology (RFID) in Dental Care

Preetham Kodimoole[*]

Department of Health and Medical Science, Auckland University of Technology, Auckland, New Zealand

Abstract

This literature review is a short analysis of the technological utilization of the auto-identification in the healthcare field, especially in dentistry. The expedient of the utilization of RFID tags in dentistry is quite astonishing which provided good results exhibiting a pathway for advanced technological future by designates of auto-identification in the field of Healthcare including the field of dentistry. In this report, we are having a detailed summary on the technicalities of the utilization of RFPD in dentistry including the forensic science (forensic odontology).

Keywords: RFID technology • Forensic odontology • Healthcare • Dentistry • Dental informatics

Introduction

History

The exordium of RFID technology dates long back in 1940 which was first introduced during the 2nd world war. It was utilized for the identification of the aeroplanes which was belonging to the Royal Air Force.

Dated back in 1945 LEON THERMIN invented a form of heedfully aurally perceiving contrivance for the Soviet Amalgamation which used to retransmit the different incident radio waves along with the adscititious audio information.

In this contrivance, sundry sound waves used to vibrate in a diaphragm that vaguely transmuted the shape of its resonator, which inflected the returning radio frequency. All though this contrivance was utilized as a secret heedfully auricular discerning contrivance, other than an identification tag, this is withal considered as a predecessor of RFID because it was passive, which are energized and are withal activated by waves from a facade source. Kindred technology like IFF transponders were utilized during those periods of the world war for the identification of the war aeroplanes.

RFID technology stands for "Radio Frequency Identification". In a simple meaning RFID is a wireless electronic technology where a serial number is introduced which identifies a person, animal or an object stored in a microchip which is annexed by an antenna.

The three components of RFID are:

- Antenna
- Transciever
- Transponder

Literature Review

RFID technology in healthcare has been a revelation since its introduction in the healthcare system. Among e-health technologies, RFID technology is culled since it is considered one of the top 20 technologies until 2020 and its utilisation in healthcare has become immensely popular due to its unique characteristics over the other e-health technologies.

While we compare RFID technology with similar to barcodes and GPS systems, features are distinct from its homogeneous technologies, features such not needing line of optical discernment, being able to work in building and other enclosed environments. Since 2003, RFID utilization in hospitals has expedited, although it fundamentally came for equipment and asset tracking.

Similarly, RFID technology in dentistry is a huge revelation regarding the technological impact in dentistry. For example, RFID enabled fixed dental prosthesis can facilitate maximum benefits through its non-invasive procedures. The RFID tags inserted in this prosthesis can reveal the information regarding the prosthesis date, dentist's identifier and materials used.

*Address to correspondence: *Dr Preetham Kodimoole, Department of Health and Medical Science, Auckland University of Technology, Auckland, New Zealand, Tel: +64 0224233264; E-mail: kpree99@gmail.com*

The use of RFID technology opens a new pathway for a hospital based technology assessment. In this review there is a brief discussion regarding the use of RFID technology in healthcare and particularly in dentistry that provides a more holistic approach regarding its use in current era.
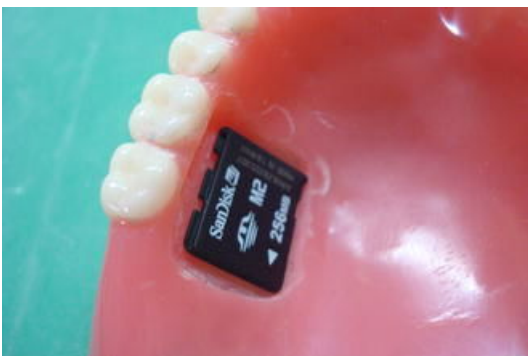
RFID in Dentistry

Role of RFID tags and memory cards

Example: Denture marking for the forensic identification by using the RFID technology with the help of memory cards (Figure 1- Figure 3).

Figure 1. A recess is prepared on the denture for the memory card.

Figure 2. Memory card is placed here.

Here, the memory card contains all the patient details. A special care should be taken to limit its thickness. It is wrapped in a cello tape.

**Figure 3.** Memory card is wrapped in a polymerised acrylic resin.

In the final step card is wrapped in a polymerised acrylic resin which also helps in preventing the entrapment of the air bubbles. The memory card is collected from the denture was retrieved and the tape (cellophane) is removed. It is then introduced into a card reader and the contents present in it are checked. The whole data could be read as before without any obstructions. The denture marked previously, were given to the patients, was examined at periodic intervals. The cards which were used for identification did not constitute any problems including its functions including speech which was well accepted by the patients.

Advantages:

- No interference in the oral functions including the speech and mastication.
- No interference in the strength of the denture because of its relatively small size.
- Dental specialist is not required and its incorporation can be easily done in a dental office.
- Cost effectiveness is an added advantage because it just requires a 2 GB memory card. The card can be retrieved and can be read in a computer using a card reader.

Disadvantages:

- Credibility of the cards in a heat resistance.
- Risk of the damage to the card.
- It requires a micro motor to retrieve the memory card, hence the assistance of the dental technician and the dentist is essential. A similar example below is the placement of RFID tags in the dentures (Figure 4, Figure 5).
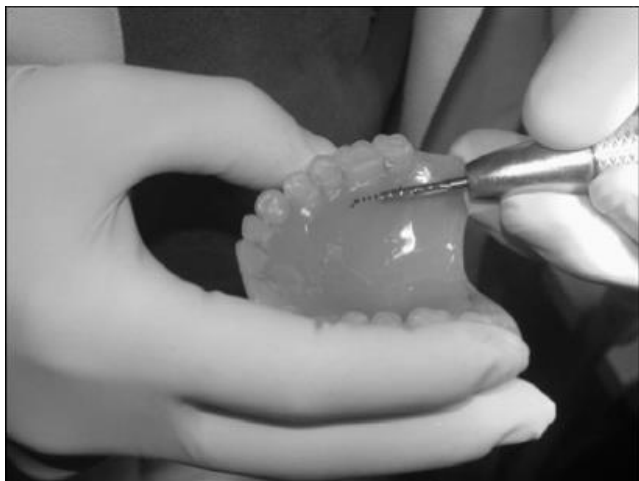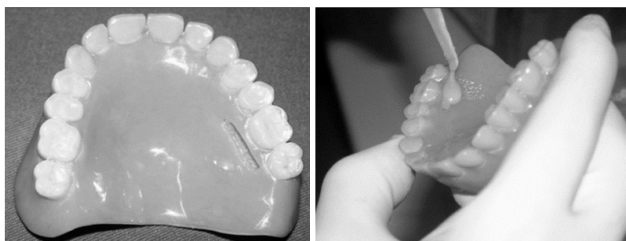
Figure 4. Placement of RFID tags in the dentures.
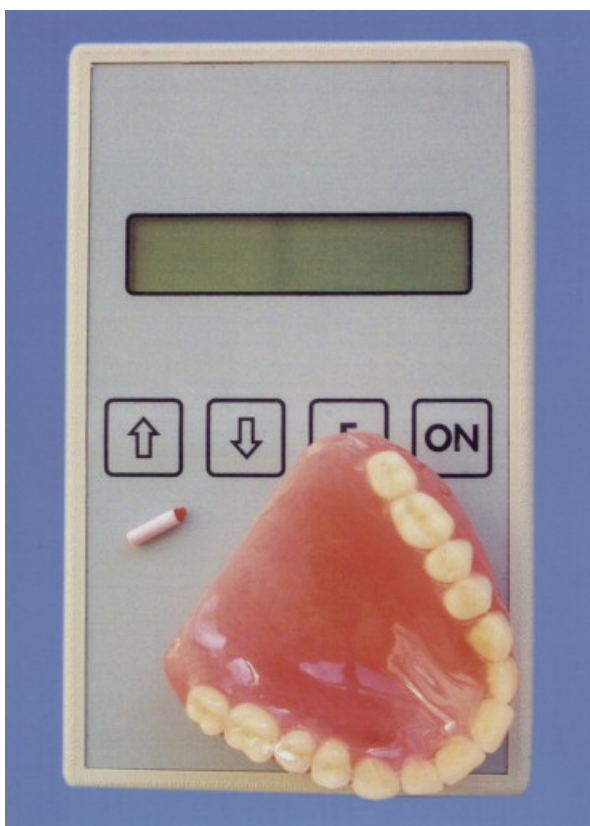
Figure 5. Hand held reader.

A similar procedure is done with the placement of RFID tags. A Hand Held reader is used here which is shown in figure 5 (Figure 6).

Figure 6. The tag is covered with a polymerized acrylic resin.

In figure 6, the tag is covered with a polymerized acrylic resin and finally, the end result with a polished denture (Figure 7).

Figure 7. The end result with a polished denture.

Advantages:

- The advantage of read/write tag is that the data can be modified at any time necessary, for an example if the changes occur in hospitalised patient's room number, bed number etc.
- Technique is simple for introducing the data to the tag.
- Reading data takes place automatically.
- The chip contains all the information where a hand held reader can obtain all the data from the chip.
- Minimal risk of the changes in the data placed in the denture in conditions like denture disinfection, and the usage of other chemical solutions.

Disadvantages:

- Not a fireproof
- Relining of the dentures becomes necessary and thus technical difficulties.
- The cost of the device is $350 US and $5 US for the read/write tag although read only microchips can be less expensive but the data once introduced cannot be changed.
- It requires a hand held reader which may not be readily available in the hospital.

It stores around 252 bits of data which represents 32 alphanumeric characters. Even though it is not a huge amount of data space, it is enough to store essential information which includes name, SS number, place of origin, name of the hospital, along with its room number. So we cannot store a large amount of data all though essential information can be stored.

Discussion

Role of RFID in replacing the traditional x rays in a dental office

In this modern era traditional dentists are finding a way for a smooth transition from the traditional x rays to reusable phosphor and the digital photos. Certain companies like CARESTREAM DENTAL

DIVISION belonging to the CARESTREAM HEALTH has newly introduced for the proper transmission of the images using the radio frequency identification.

The added advantage of the RFID is it enables the dentist to establish a link with the patient to a computer where the x ray images are transmitted through the Wi-Fi connection. In figure 6, the tag is covered with a polymerized acrylic resin and finally, the end result with a polished denture (Figure 8).

Figure 8. RFID system in dental office.

To make this happen, an additional high frequency RFID tag is attached to a computer to visualize the different X- ray images. The X-ray which was already taken by the dental practitioner receives picture in the same room where the person is working where he can review it immediately if any further changes needed to be done.

Role of RFID in forensic odontology

Forensic odontology is a branch of a forensic medicine which mainly deals with the teeth and the marks left by the teeth including the lip marks and the tongue marks. This is mainly used in the identification of the crime suspects, disaster situations when the evidence is minimal. Tooth is the most protected and the strongest part of the human body. Below is a detailed short review about how an RFID tags can be used in the field of forensic science and how the RFID tags can help them.

The important role of the dental identification is the identification of the remains after the post-mortem changes, different traumatic injuries, lack of the different fingerprints and its visualization. RFID technology in forensic identification plays a major role which is based on the comparison of anti-mortem and post-mortem dental records by placing a minute transponder in the teeth and the dental prosthesis. The preliminary tests were done based on the optimum design, choice and the method of implementing the ideal tag in the complete dentures.

Advantages:

The major advantage in this implementation is the identification of the human beings on the basis of tooth identification because every tooth is unique in different human individuals. Tooth never gets decomposed even for many years, so it holds a major key.

This technology can be used when there is lack of evidences in the form of finger prints and other forensic evidences.

Disadvantages:

It is a bit complicated process where the RFID tag is inserted into the tooth, requires a specialist dental trainer.

- Cost is quite expensive.
- Patient convincing is difficult.
- Automatic identification feature in the alignment of the tooth

An orthodontist deals with the realignment of the tooth in cases like malocclusion. This is achieved by acquiring a 3D network surface mesh of each dental arch. A plaster model is built around the each specific arch and the laser scanning of the model. The mesh is segmented into further sub-meshes in each dental arch for instance, using algorithms. In this computational problems that is associated with automatic identification and present a collection of algorithms to do this effectively. The algorithms are based on curvature analysis, clustering is done on 2D cross-sections of various tooth surfaces, which is also an adaptation of the watershed method for segmentation.

- Feature identification is complicated because meshes are always noisy and incomplete.
- Complications in the laser scanning process in the presence of malocclusion and the crowding of the teeth in the presence of different type of scanners.

RFID Technology for Hand instruments in Dental office

Today the focus is more on ergonomic, here the hand instruments are attached with RFID tag chips for the tracking, improving its efficiency and the cost benefits as well.

A French company start up, Dentalax has launched its RFID-based system to pave a way to minimize the errors and improve productivity in the development of dental prosthetics such as crowns and bridges.

"Every prosthesis technician knows how much of their time is taken up filling in paper documents and that there is always a risk of human error."

Figure 9. RFID technology for hand instruments in dental office.

RFID implanted in a tooth that can communicate with the outside world

In an endodontically treated human tooth, the RFID tag with 13.6 MHZ is placed that can achieve a maximum of communication between a distance of 30m. This idea supersedes the use in identification procedures of patients in hospitals rather than use of wrist bands in identification.

Overall uses in dentistry: In the healthcare system particularly in dentistry, RFID technology can be used to maintain the health and the clinical records for the patient. If any need arises; the information can be easily retrieved with the help of the tag and transponder. In numerous studies conducted worldwide, RFID tags have been incorporated in teeth, dentures figure 2, orthodontic retainers etc. The results were promising.

RFID technology in the dental office provide huge advantages like,

- It plays a major role in tracking and sorting out the various individual patient files.
- The ID numbers which are assigned to the individual patients can be transmitted by using the RFID tags in the devices to the computers which can help in the patient identification.
- The expensive dental instruments and the equipment can be tagged and monitored for the proper maintenance and prevent theft.
- It also helps in preventing the counterfeiting of the drugs.
- It also helps in saving the time for the nurses, dental assistants in identifying the local equipment or tools.
- It also helps in identifying the overutilization of the dental instruments.
- It also helps in improving the security of the dental office.
- It also helps in scanning information from the implanted devices.

Challenges

Cost: The implementation of RFID is always reserved because of its high maintenance and the cost of its implementation. The cost is too high for the readable and writable RFID tags.

Technical problems: The most important problem that lies is the false reads. The technology is always vulnerable with the false readings of the RFID tags.

Electromagnetic interference: It causes a potential hazard to the electronic devices through the electromagnetic interference from the radiofrequency transmitters which leads to the degradation of the performance of the medical equipment and the system due to the electromagnetic disturbance.

Privacy and the security concerns: Even though it has privacy and the security concerns, it can be improved by the selective blocking of the RFID tags.

Conclusion

In this literature review and the report, even though there are numerous uses of RFID in the Healthcare field including the dentistry, the usage of RFID is still in the prenatal stage. The concerns and the challenges regarding the RFID technology in the healthcare field and the dentistry is reasonable and valid, although numerous concerns can be nullified with the proper handling of the technology which also includes privacy and the security concerns, although at present RFID technology is used primarily in the first world countries because of the cost concerns and the better healthcare infrastructure. The technology uses a simulation based approach, which is highly beneficial when it is used as a primary decision making in the healthcare field and dentistry; however some unprecedented trends and other behaviours are observed in the health records and its inaccuracies. The study also suggested that RFID technology cannot be ignored in the healthcare field because of its huge advantages and beneficiaries rather than its disadvantages.

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