

Building an Interactive environs for Blind Students with RFID Technology.

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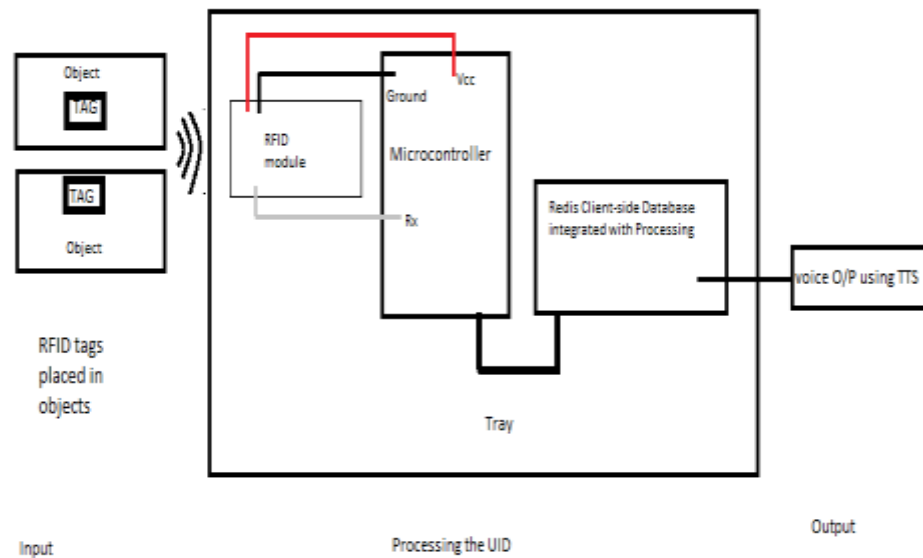
Abstract — This paper outlines an interactive-object recognition system for the blind students using the Radio-frequency identification (RFID). RFID appears as an effective solution for object identification. This paper also gives a overview of the Radio-frequency identification technology and identification. Using a low frequency Radio-frequency identification integrated indoor environment, a framework was created to assist the blind to interact and identify with their surroundings with audio messages. The framework created uses an Arduino- Atmega328 micro-controller interfaced with a Low Frequency Reader Module. The RFID reader recognizes objects carrying passive small tags through unique, distinct codes. The object code, name and other details are logged into a Processing Script integrated with Redis DB and audio libraries through Serial Communication. This system successfully identifies various objects irrespective of their shape, size and physical attributes.

Keywords — Radio-frequency identification (RFID), Audio libraries, Redis DB, Serial Communication, Processing, Object Recognition.

INTRODUCTION

The sense of sight, among the other four senses constitute the perception of a normal human being. Every activity demands a person to perceive it visually first. The loss of this sense can make the most basic everyday tasks arduous. The life of visually impaired students can be strenuous. Moving about and navigating in unknown campuses can be extremely hard. They should be constantly taken care of, else would injure themselves due to large obstacles posing as barriers in their way. RFID is a method of identification of transponders (RFID tags) through radio frequency transmission. These devices are referred to as RFID modules or RFID readers. These readers obtain the unique code from the RFID tag without contact (wirelessly) and they either store the data or transmit it to a micro-controller where the data can be further manipulated. An RFID system mainly functions in four specific ranges of frequency spectrum: Low Frequency (LF), High Frequency (HF), Ultrahigh Frequency (UHF) and Microwave.

Fig: 1.0 Project Overview. The system utilizes RFID to detect objects in an indoor environment for blind student



Each spectrum has its own range limitation. The Low frequency band covers frequencies from 30 KHz to 300 KHz. Typically LF systems operate at 125 KHz, although some systems operate at 134 KHz. This RFID LF system offers a very short read range of 10cm, and has slower read speed.

The High frequency band confers ranges from 3 to 30 MHz Most HF RFIS systems operate at 13.56 MHz offering a read range between 10cm to 1m. HF RFID systems experience moderate sensitivity to interference. The Ultrahigh frequency band covers the range from 300 MHz to 3 GHz. Systems complying with UHF use 860-960MHz band. The read range of these systems can be as long as 12m and these systems have a much faster data transfer rate than LF or HF.

The information on the RFID tag is contains a unique identity code. When the RFID reader transmits that specific frequency, the tag responds and sends its UID to the reader. When it comes to power source, tags are of two types: Active and Passive. Active tags have an inbuilt power supply powering the circuit. They have a longer wireless range and have higher data transfer rates. Passive tags do not have an inbuilt power supply and they rely on the RFID reader for the power. RFID has become widespread in retail and shipping where it is used as an alternative to bar codes to detect and identify products and shipments. In recent years, RFID based identification have become popular in applications such as security systems, library management, vehicle security, electronics barcode labels and toll systems. In an indoor environment, blind students can identify several objects using a RFID reader which identifies objects carrying passive RFID tags. All codes and their respective objects are initially registered into the Redis DB. The Low frequency passive tag when it is in a vicinity of less than 10 cm around the reader, it is wirelessly recognized by the RFID reader. This information is relayed to the Arduino Micro-Controller which communicates with a Processing Sketch through serial communication. The processing Script stores these codes from the micro-controller and compares the code which is predefined in the Redis DB. The recognized object name and its details is transferred from the Redis DB to the Processing script, where the messages are converted to modulated speech using advanced (Text-To-Speech)TTS libraries. This system can also be made more accessible if native language TTS support is added. Many experiments have been successfully conducted to demonstrate such applications. Results have also been compared with the existing systems and plotted. Installation is easy, development cost is low, and efficiency is good the area of recognition is below 0.1m. The other advantage is that it is applicable in indoor environment. The passive tags used were relatively cost efficient and can be integrated to smaller sizes for future work.

This paper is organized as follows: Section 2 describes related work in the field of RFID application; Section 3 describes the architecture of the system; Section 4 describes experiments conducted and results and Section 5 concludes the paper and proposes future work.

II. RELATED WORK

For related researches on RFID [1], [4], [5], [8], [9], [10], [11], [16], [18] and [22] are the prominent examples. RFID systems have become common for identifying and tracking objects as discussed before. This paper presents a study on identifying an object carrying an active RFID tag. The study incorporates processing of the signals received from transmitters, in a way to recognize the object that carries the tag efficiently. Similar projects provided a read range of 2m and 5m respectively. However, this method proved to be inefficient as multiple objects would get recognized when the area of recognition was substantially increased. It resulted in low accuracy. Therefore, a system with low vicinity of recognition was needed to be developed.

Utensils and other objects in the house or building carry the tags and transmit the data wirelessly to the Reader embedded. The reader constantly scans its surroundings at a low frequency spectrum. When the passive reader is in close vicinity to the passive tag, the resonant frequency powers the passive tag and the UID (Unique Identification) is sent to



the micro-controller. The processing Script running parallel in

Fig: 2.1 : Arduino (Left) interfaced with the RFID reader (Right)

the desktop computer receives this UID through serial communication. The processing Script returns a synthesized voice output. No pre-recorded messages were stored into the Redis server to reduce the effective. The system is slightly expensive because of use of Arduino Microcontrollers. The entire system is initialized when the processing Sketch is started. The Arduino Micro-controller is USB powered to reduce the reliability on batteries. The data transfer is instantaneous, the synthesized voice output is given by the system as soon as the object is recognized by the reader. Even though this system works best when smaller

tags (micro-tags) with adhesives at one end are used, tags with bigger physical dimensions were used in this project to reduce the cost of the transponders. But, the functionality of both the tags remain same irrespective of the physical dimension of the transponder.

From the above discussion it is concluded that RFID is a powerful tool for providing assistance to the blind. There is a possibility of designing a cost effective system which has an improved performance in most of the respects and will also work optimally in many different applications. RFID based systems appeared to be the best promising solution and easy to use.

In the nutshell, RFID is only one of numerous technologies grouped under the term Automatic Identification (Auto ID), such as bar code, magnetic inks, optical character recognition, voice recognition, touch memory, smart cards, biometrics etc. Auto ID technologies are a new way of controlling information and material flow, especially suitable for large production networks. The RFID technology is means of gathering data about a certain item without the need of touching or seeing the data carrier, through the use of inductive coupling or electromagnetic waves. The data carrier is a microchip attached to an antenna (together called transponder or tag), the latter enabling the chip to transmit information to a reader (or transceiver) within a given range, which can forward the information to a host computer. The middleware (software for reading and writing tags) and the tag can be enhanced by data encryption for security-critical application at an extra cost. RFID is the technology of choice for object identification and tracking.

III. HARDWARE AND SOFTWARE ARCHITECTURE

A low cost LF RFID based solution for blind students or visually impaired to recognize and interact with the objects in their surroundings was designed. A block diagram of the system is shown in Fig 1. This system contains an RFID module / Reader interfaced with the Arduino micro-controller. The passive tags (With an operational Frequency of 125 KHz) are placed onto many objects. Fig 2.1 Shows the RFID Reader module interfaced with the micro-controller. The passive tags chosen in this project had bigger physical dimensions, in order to make the entire system cost productive. In future, edible/non-edible-Micro-tags (Fig - 2.2) having the same operational frequency and supported with an adhesive can be used. The Arduino Script written on the micro-controller continuously scans for the passive tags at a certain frequency, through the RFID reader. When the contactless/Wireless passive tag is brought in close vicinity to the RFID reader, the UID (Unique Identification) code embedded in the passive tag is transferred to the Arduino, making a “click” sound through the speakers embedded in the reader indicating that a passive tag was recognized. From the Arduino, the data is transferred to a processing Script that runs parallel on a desktop computer, through Serial Communication. Using Redis DB in the processing Script, all the UID’s are stored initially stored in the database and linked to the corresponding objects and their information. When the object is found, (Fig 2.3) it result is locally logged and the output is given out in the form of synthesized speech. Another library was written to enhance the speech rate, pronunciation, and multiple voices were added.

Fig -2.2: Edible/Non-edible Micro-RFID tags with the same operational Frequency.

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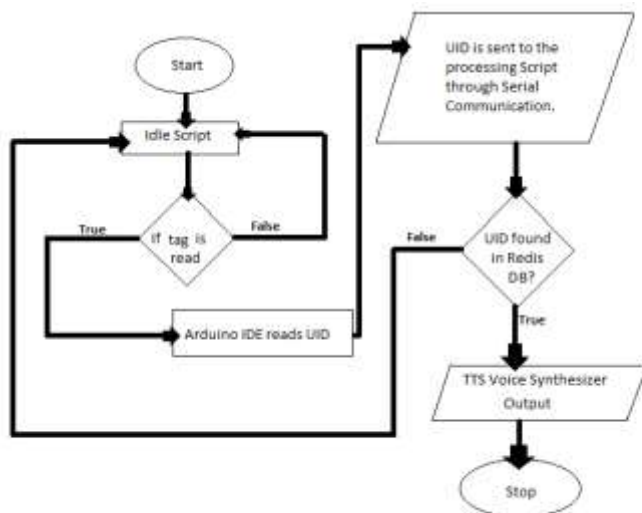
# Redis-Wrapper v1.1.1 - https://github.com/voidplus/redis-processing
# Jedis-Library v2.6.0 with Redis v2.8.5 support - https://github.com/xetorthio/jedis
# Info: Redis-Server found.
Server Created!
Element exists
Found : 06505984 at 06505984
Vitamin A
Fetching more information
Vitamin A is a group of unsaturated nutritional organic compounds, that includes retinol, retinal, r
Vitamin A deficiency can result from inadequate intake, fat malabsorption or liver disorders.
Vitamin A are highest in liver and fish oils. Other sources of preformed vitamin A are milk and eggs.
!****Done*****
Element exists
Found : 06515638 at 06515638
Vitamin B
Fetching more information
Vitamin B also called cobalamin, is a water-soluble vitamin with a key role in the normal functionin
Vitamin B deficiency can result in Immune system disorders, such as Grave's disease or lupus and Atr

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Fig - 2.3: Object search is logged locally and the corresponding object output is given to the user through synthesized speech.

A clear working of the entire system is shown in the below flowchart.

IV. EXPERIMENTS AND RESULTS



The output of the system is object identification. By using RFID tags one can evaluate system's performance. We used 3 passive RFID tags. These tags were assigned as Vitamins (A, B, C) respectively. When a tag was detected, the sequence of unique numbers printed on the tag is transmitted to the reader. When the object was recognized, it was sent to the Processing Script through Serial Communication.

The numbers of the passive tags in the processing Script were decoded and interpreted as the corresponding Vitamin with the help of the pre-initialized Redis database. Along with the voice information of the objects in the database, images of the objects (here, Vitamins) were supported. (Fig 4.1, Fig 4.2) and the synthesized voice output was given almost instantaneously. The minimum distance needed for recognition and the time required was logged (Tab: I). All data that was converted to speech was logged. (Fig 4.3)

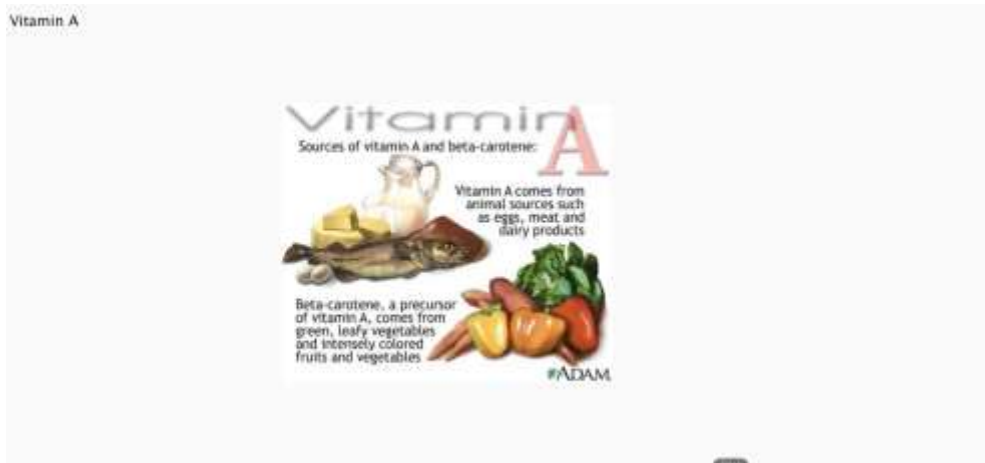


Fig 4.1, 4.2: Images of the objects stored in the Redis DB along with the information of the object

Data	Distance (cm)	Response Time (sec)
1	3	0.9
2	2.7	0.6
3	2.9	0.6

Tab I : Log of distance and response time of the RFID system

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# Redis-Wrapper v1.1.1 - https://github.com/voidplus/redis-processing
# Jedis-Library v2.6.0 with Redis v2.8.5 support - https://github.com/xetorthio/jedis
# Info: Redis-Server found.
Server Created!
Element exists
Found : 06505984 at 06505984
Vitamin A
Fetching more information
Vitamin A is a group of unsaturated nutritional organic compounds, that includes retinol, retinal, retinoic acid.
Vitamin A deficiency can result from inadequate intake, fat malabsorption or liver disorders.
Vitamin A are highest in liver and fish oils. Other sources of preformed vitamin A are milk and eggs.
****Done****
Element exists
Found : 06515638 at 06515638
Vitamin B
Fetching more information
Vitamin B also called cobalamin, is a water-soluble vitamin with a key role in the normal functioning of the body.
Vitamin B deficiency can result in immune system disorders, such as Grave's disease or lupus and Atrophic gastritis.
Vitamin B is found in fish, bread, whole cereals, rice, soya beans etc
****Done****

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Fig : 4.3 - Data logged into the system for future reference.

V. CONCLUSION AND FUTURE WORK

We have successfully devised an environment which enables the blind / visually impaired children to interact with their surroundings in a way that could never interact before. It makes use of low frequency RFID reader and passive tags. These tags operate wirelessly using power from RFID reader. They transfer the tag id to the reader and further to the micro-controller. We also exported the Processing Script into an application successfully compatible under Windows and Mac. In future, the system would be capable of handling multiple efficiently. We also want to support native language with personalized voice that would help blind students understand their environment in a better way. A more efficient, short range reader can be devised for the same purpose. The size of the passive tags can be reduced substantially by using micro-tags. In the future, this entire system can be implemented in a real scenario where blind students can learn and interact with their surroundings with greater ease

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