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BROCHURE on **RFID-radar**™ system

Identifying and locating low cost RFID transponders
"A new identification technology"

RFID-radar *represents a major technical development in the technology of Radio Frequency Identification (RFID).*
RFID-radar *now adds accurate 2D location information to the identity information that was provided by previous RFID equipment.*

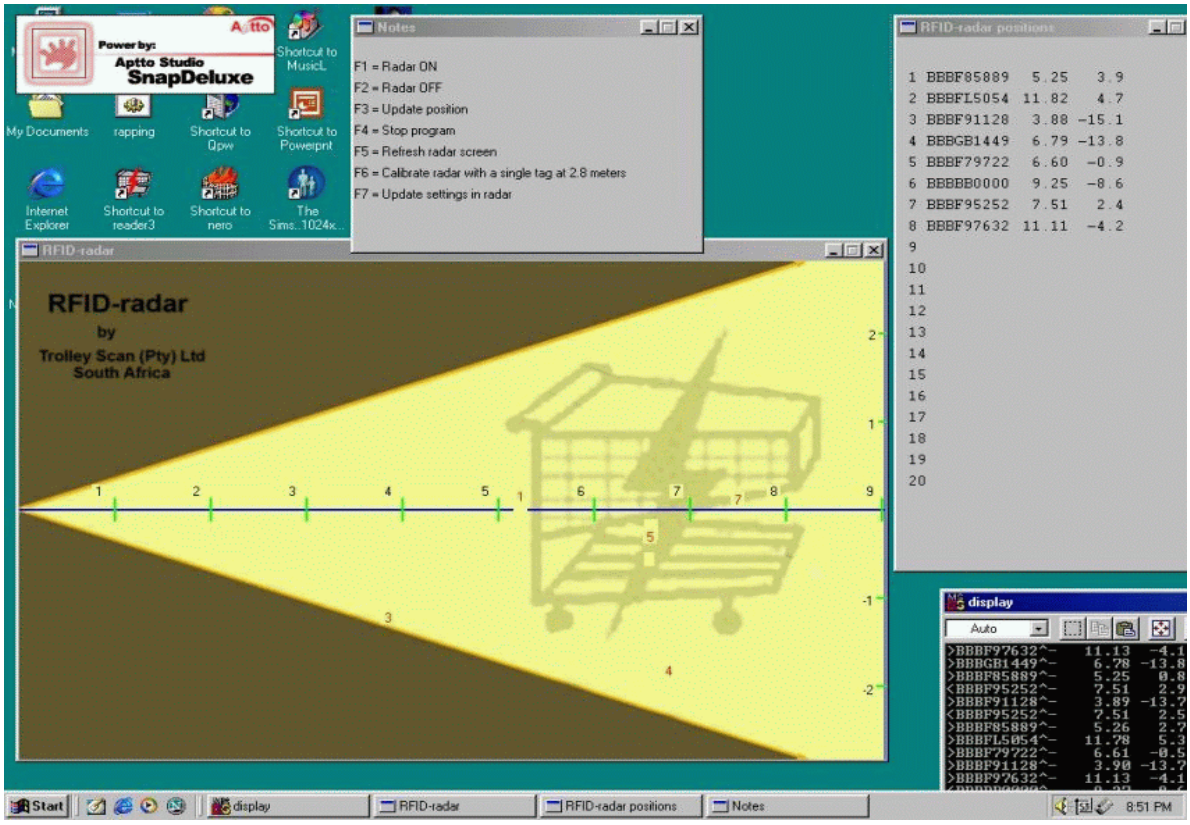
HOT NEWS - New SURVEY mode added to features

Trolley Scan are delivering first commercial versions of this technology to clients. This document describes the equipment, software and services that are supplied.

The new SURVEY mode allows the detection of long term movement of structures such as bridges, dam walls, buildings and tunnel walls using simple equipment.

Trolley Scan's new RFID-radar with antenna system for 2D scanning

The system operates in different accuracy modes. The system can measure the absolute position of multiple transponders to tens of centimeter accuracy, or the relative movement of transponders to millimeter precision



The demonstration software to be run on a Win32 based computer with a 1024 by 800 pixel display. Four windows are shown. Bottom right shows incoming data from the RFID-radar, bottom left shows position of transponders relative to reader, top right shows position information tabulated and top left shows notes on hot buttons.

What is supplied

? Processor box containing the energiser,amplifier, receivers and processor. Rack operates on 115/230 volts and provides RS232 data to the client's computer for display.

? Antenna array for 2D scanning comprising 3 high gain patch antennas

? Ten 5uW(microwatt) claymore Ecotags for attachment to metal/hard items with an operating range of 30 meters, five 5uW stick Ecotags with 20 meter operating range in air and five 200uW Ecochiptags in credit card format.

Software source code for a sample program to run on a Win32 computer (to be supplied by the client), which will display data from the radar.

How do you use the radar

? Set up the antennas as per the directions.

? Connect the antennas to the processor module

? Connect the computer you wish to use for the display to the processor module via an RS232 cable (19200 baud,N,8,1)

? Connect the processor module to 115/230 volt mains and switch on

? Place a tag in the energising zone

? The processor will report the identity of the tag on the RS232 line immediately. Initially the range will be quoted as the starting value, but after a short time the processor will lock onto the tag and report the identity, range and angle measured from the antennas at one second intervals.

? If you do load the sample software for the display program on a Windows 98/NT... (Win32 based) computer, the program will display the incoming data, the location of the tags in numerical format,and a graphic of their position. The display will track 20 different tags. The source code of the display program is written in Console Compiled basic from Power Basic. You will be able to edit the code to your requirements and recompile the code if you buy the complier from Power Basic (www.powerbasic.com)

What data is provided by the processor in the radar

? The processor in the radar can handle up to 50 transponders in a zone at one time

? The processor outputs at one second intervals for each transponder

Identity of the transponder
Range to transponder in meters
Angle to transponder from reader
A status symbol showing whether the data was measured or if it is a predicted value.

The modes of operation of the radar

Acquisition

When a transponder enters a zone of the reader, the radar will report the identity of that transponder immediately. It will be reported with the entry coordinates used for transponders whose range has yet to be determined. (Typically set to a range of 60 meters, angle 0 in this version). The radar has to lock onto the transponder to determine its range, a process which takes many seconds.

Range and tracking

Once the transponder and the reader are locked onto each other, the radar will report the range and bearing of the transponder. The reader is able to detect changes in the range of the transponder of small distances, allowing the radar to

Front panel of RFID-radar

determine the current movement of the transponder and use this data for predicting current location. The radar can measure the location

Tracking when signal lost

Based on the accurate measurement of movement in the ranging mode, and knowing the last position, the radar will predict the current location of a transponder for a period of 10 seconds in the event of a loss of signal, such as the transponder passing behind a screening object. If the signal is restored in this time, the position will be corrected and normal ranging operations will continue. If the signal takes longer than 10 seconds to return, then when the signal is restores it will be reported initially in the Acquisition phase.

Although the above description applies to a single transponder, the radar will process all the transponders in the field at the same time independently of the state of any other transponder.

Calibration

The radar measures the electrical distance the signal travelled from the transponder to the reader. In order to report this correctly, taking into account different path lengths due to cabling changes etc, it is necessary to calibrate the radar once it has been setup. All measurements are about a signal travelling at the speed of light (300 000km/sec)

A SINGLE transponder is mounted on a holder 9 meters in front of the reader on the zero angle radial, that is directly in front of the reader. This is automatically ranged by the radar when it switches from the acquisition phase to the ranging phase.

The "CALIBRATE" command is sent to the radar from the display software to tell the radar to calculate and use the calibration factors required to show a radar distance of 9 meters correcting for cable lengths and speed of radio waves through those cables. The radar stores this value in its permanent memory for use when the radar is powered up in the future. It is not necessary to calibrate the radar again until it has changes that might change the electrical path length(such as changing the cables to the antenna).

RF interference and operating frequency

The radar operates in the spectrum allocated for RFID by individual countries. The radar has a property called frequency agility, which allows it to be set in the factory to operate at any frequency between 860Mhz and 960 Mhz depending on the requirements of that country. The radar uses a tag-talks-first protocol that uses just 10 kilohertz of spectrum to operate, generating virtually no interfering signals and allowing multiple radars to operate at the same site. The radar outputs between 0.5 watts and 3 watts which can be set by the user.

(The radio spectrum of the RFID-radar is similar to that of the Trolleyponder RFID readers, systems that have been supplied to users in 52 countries with no reports of interference being reported by its users, either from our equipment on others devices or of other devices interfering with the readers. RFID-radar is one of the cleanest RF systems available for RFID type equipment.)

Transponders and range

The current version of RFID-radar is being supplied with 5uW stick Ecotags, 5uW Claymore tags and 200uW Ecochiptags from Trolley Scan.

With technological developments, as the sensitivity of the tags reduces from the current 5uW versions, so the operating range of the radar will increase.

Stick tag and credit card sized transponders

The RFID-radar system is supplied with the latest 5uW transponders with operating range of 30 to 35 meters.

Commercial versions available

RFID-radar is a patented technology that is only available from Trolley Scan.

Trolley Scan are releasing the technology in the following packaging

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Stand alone version - available immediately

This version is based around a state of the art digital signal processing module running an assembler language program, capable of tracking 50 transponders at a time. The version includes an RFID mode, and advanced data filtering ability to report on transponders within a range spacing, or to report on the movement of a single transponder. Just plug in mains and a computer and you have a fully working system

OEM version - available immediately

For companies that want to build the basic building blocks of the RFID-radar into their projects. The key modules are supplied without power supplies or packaging

Comparing RFID readers with RFID-radar

The ability of RFID-radar to determine position as against only identity for RFID readers will lead to the development of an entire new set of applications for RFID. The RFID-radar is not likely to replace conventional RFID readers and the two techniques will operate side by side. In many applications, conventional RFID readers will be the better choice for the project.

Points to consider are:-

? RFID reader generate much less data than their RFID-radar counterparts, meaning simpler implementation. The RFID-radar outputs data for all transponders at one second intervals continuously. The RFID reader only outputs data when a

transponder comes into the energising field.

? The RFID reader is much simpler and cheaper

? The RFID reader is easier to interface to applications. The RFID reader can handle much faster moving targets (Trolley Scan versions up to 300kph)

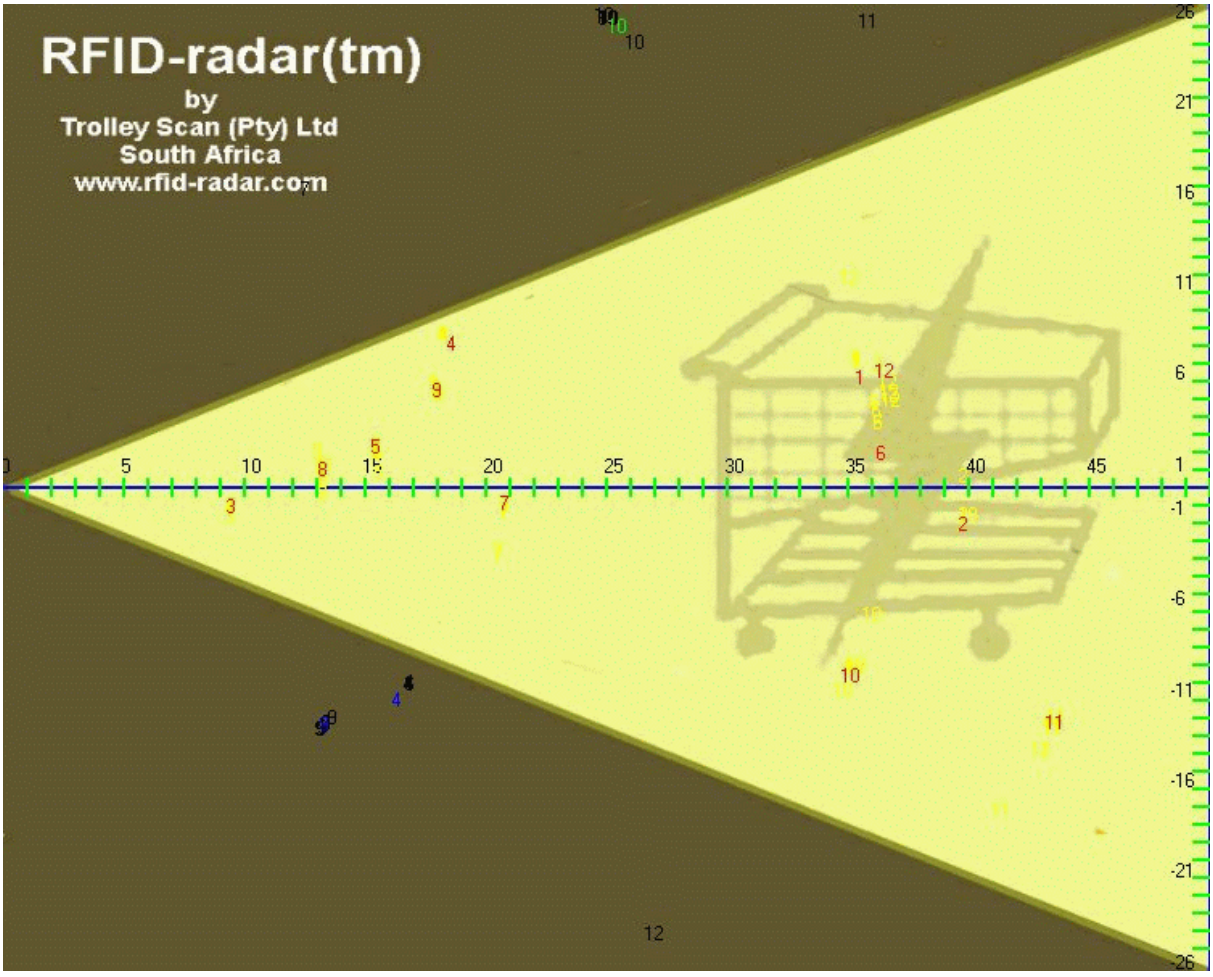
? The RFID reader can handle larger volumes of transponders simultaneously.

RFID reader systems can be found at www.trolleyscan.com - Trolley Scan (Pty) Ltd

The RFID-radar has an RFID mode which is selected by software. This reports as soon as a transponder enters its detection zone at speeds up to 300kph. Just the identity of the transponder is reported, and only once for each entry into the zone. The RFID-radar can be switched back to radar mode via software which will result in the reader reporting the identity and location of all transponders once per second.

How accurate is RFID-radar?

The radar measures the distance a signal travels from the transponder to the reader. It measures this distance currently to an accuracy of a a few tens of centimeters, (and can measure movements to a few millimeters in relative made) from ranges of 1 meter to 40 meters, depending on the transponders used. It measures the angle of arrival of the signal



Location of 12 transponders. Distance measurements in meters. Showing repeated measurements on same transponders while stationary.

travelling from the transponder to the reader, so giving a 2 dimensional position for location, based on accurate range measurements. The radar measures the range of up to 50 transponders in a zone at one time. The measurements are reported to the host computer at a display rate that is set-able from once per second to once every twenty seconds (OR for those wanting fast data at rates up to 50 times per second). The range measurement can be made through hard objects such as walls and packaging. If the path is interrupted by an object cutting off the direct path, the radar will hold its position of the transponder and pick it up again when the path is re-established

Absolute/Relative/Survey mode.

The radar provides three different means of measurement of range for different types of application. In all cases it is measuring the radio path length from the transponder to the reader.

Absolute mode

This is the conventional mode where the system measures the distance between the reader and each transponder. In order to determine the distance, it is necessary for the transponder to be stationary relative to the reader for 20 seconds while the distance is determined. Thereafter the transponder can move slowly and its range updated.

Relative mode

The system can measure changes in the radio path length very accurately. Movements of as small as a millimeter are detected instantaneously for all transponders in the field of operation, whether they are close to the reader or at distances up to 40 meters. This feature means that the system can be used to monitor continuously movement of structures such as bridges with traffic loading, wind and water loading of structures and similar applications.

Survey mode (new feature added Dec 2009)

Using the features of detecting millimeter changes in distance over long ranges, the SURVEY mode allows structures to be monitored periodically with the equipment being removed between measurements. By recording the measurements from the reader site to many transponders placed on the structure, and comparing them at some later time when the reader equipment is setup again at the same location, movement over the intervening time can be determined accurately for all the transponders. This could be used to monitor retaining wall movement in potential landslide situations, swelling dam walls, collapsing roof structures and the like.

Limitations of RFID-radar

Current limitations of the RFID-radar system which are going to be addressed in the future are:

? Number of transponders in zone limited to 50 (will be increased to 100 in later versions)
? Speed of movement limitation for the tracking and prediction of movement of the transponder
? Range limited to about 40 meters with current RF power 5uW passive stick type transponders..
? Works at present only with the current range of Ecotag type transponders.

Specification

Accuracy range(ABSOLUTE mode)	50 centimeters
relative movement accuracy (RELATIVE/SURVEY mode)	1 millimeter
Max no of dimensions	3 (This version is 2D)
Pointing accuracy	0.2 degree
Maximum range of reader	40 meters (mathematical) Energising dependant on transponder type-30 to 40 meters for 5uW tags
Transponder technology	Passive TTF (Tag talks first) protocol
Multiple transponders	Up to 50 in the energising zone
Interfacing to computer network	RS232
Operating frequency of reader	860 to 960 MHz
Bandwidth used	10kHz
Interference zone with second reader on close frequency	4 meters
Output power	0.5 watts to 3 watts set-able by user
Antenna type	High gain patch-like antennas
Multipath discrepancies	Range corrected for multipath

Software controllable modes of the radar

The display software can control the operation of the radar with the following commands

ON	Turn on the energiser field to power up the passive transponders
OFF	Turn OFF the energiser field of the reader
SLICE	Only report those transponders that are within a 10 meter range window. Position of the window set-able by software
WHERE	Report the location continuously of one designated transponder in a field of many transponders
RFID	Switch to RFID mode - report identity only of new transponders entering the zone

RADAR	Switch to RADAR mode - Report identity and location of all transponders in the zone.
CALIBRATE	Calibrate the radar for new electrical cable lengths.
DUMPRATE	Time is seconds between reporting the location of all transponders(between 1 & 20 seconds per report of all transponders
FASTDUMP	Report location of transponders at up to 50 per second
QUIET	Only report transponders specified by WHERE command or SLICE command.
RELATIVE	Report the movement of the transponders to millimeter precision from the starting position
SURVEY	Report the movement of the transponders to millimeter precision between different measurement periods
ABSOLUTE	Report ID and location of transponders - normal mode

Speed

RFID-radar was initially developed to monitor static situations where there is no movement between the transponders and the readers during measurement. Clients have requested that the abilities of the system be improved to monitor moving transponders also with the same precision and this is the direction of the current research.

At present the radar uses a measuring stick of approximately 7.1 centimetres. To measure the speed correctly, the reader needs to receive valid codes from transponders at time intervals such that at least two valid measurements are received during the travel of 7.1 centimetres. This restriction limits the number of transponders that can be in the field at the time the speed measurements are made, as each uses up some of the capacity of the communications channel between the reader and transponders for sending its data. At present a single transponder (special type) can be tracked at 51kph, if there are two then the speed drops to 8kph, four at 3kph etc.
Trolley Scan have a project to look at this limitation by introducing time as a dimension to the reader and applying curve fitting techniques. Other routes might be to shorten the data stream from the transponders.

How does RFID-radar work?

The radar makes two measurements on each signal received from each transponder in its receiving zone - namely a range measurement and an angle of arrival. It is the ability to measure range with narrow bandwidth that make this an outstanding unique RFID instrument. The system uses the same transponders that are used by conventional RFID readers allowing RFID-radars and RFID readers to monitor the same transponder simultaneously.

Light and radio waves travel at the speed of light, namely 300 000 000 meters per second. RFID systems need to operate in a crowded RF spectrum, where other RFID systems, cell phones, radio stations and other communication users have to share the available radio spectrum. RFID-radar uses just 10 kilohertz of bandwidth to operate, meaning it can detect time differences only as small as 0.1 milliseconds, or 0.0001 seconds. In this time the radio wave will travel 30 kilometers, or 30 000 meters or 3 000 000 centimeters Yet the radar is able to determine the range of the transponder based on its received transmission to an accuracy of a few centimeters, or nearly 1 million times better than its basic time measuring properties. If we used a conventional military radar approach and wanted to get centimeter precision, then we would have to measure the time of flight to 0.3pico seconds ($.3*10^{-12}$) which would use 300GHz of radio spectrum.

RFID-radar pay for this million times improvement in the timing accuracy of the basic system by taking a longer time to determine the exact position. As a result it is well suited to a static situations where transponders are relatively stationary. However developments are in progress to address the accurate tracking of movement by adapting some of the principles of operation.

The angle of arrival measurement is virtually instantaneous and used in conjunction with range gives a 2D positioning system from a single measuring location. Measurements in RELATIVE and SURVEY mode are instantaneous.

Costs

To cater for further improvements, purchasers of the RFID-radar prototype systems will receive software updates for free, and can at any time return at their expense the RFID-radar system to Trolley Scan for update to the current version then in production. Upgrades will be performed at a cost of parts plus small percentage basis, with the owner covering the transport costs.

The RFID-radar technology is just over 6 years old and is in use in more than 27 countries. We are continually improving performance based on feedback from clients and our better understanding of the issues. These changes are generally incorporated in software improvements in one of the four computers that are used in the RADAR. Updates generally will be in the form of software and can keep existing owners of systems current with the latest developments.

Selling price of the Commercial RFID-radar is

? EURO 3570 plus freight
? US$ 4285 plus freight (approx - exchange rate currently 1 EURO=US$1.2)
? R39600 plus VAT

The radar in 2D format weights 12.5kg and is shipped in a 32 by 32 by 46 cm box

How to order a system

If you want to purchase one of these systems, please fill in the order form.

Trolley Scan will specially build the system for your order and have its frequencies set for the RFID frequency in your country. Trolley Scan will email you a Proforma Invoice for a bank transfer into their account/ or you can pay via credit card. Within 7 days of receiving the transfer, the system will be handed over to the courier company for delivery to your door, (Incoterms DDU (Delivered, Duty Unpaid)).
The delivery by the courier company takes four working days.

Response form http://rfidradar.com/formorder.html

RFID-radar is a development of Trolley Scan (Pty) Ltd (South Africa), one of the world's leading developers of UHF RFID technology.

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