Robo-Pi Landmine Detection Approach using Wireless Communication

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Abstract - *This paper depicts the plan and execution of an electronic metal indicator prepared remote-controlled robot that can be utilized in land mine identification without placing people in mischief's manner. The metal identifier can recognize secured metals and the robot can be controlled remotely from a separation. The thoughts and ideas from the hypothetical stages are shaped into the physical equipment parts by production of a model. By then programming projects are coordinated into the framework in order to test and investigation the thoughts that had been shaped. In this paper authorized entry from the user to be done and controlling the robot module is achieved using python shell, we use MATLAB simulation to classify the type of landmine based on neural networking (machine learning).*

Key Words: OpenCV, Mine indicator, Metal Locator, Haar Cascade Classifier, Raspberry Pi 3 Model B, ZigBee, neural network, MATLAB.

1. INTRODUCTION

Web of Things, Telecommunications, mechanical autonomy and numerous other innovative terms have as of late prepared an extensive piece of our regular exercises. With its upsides and downsides, innovation could tackle a great deal of serious issues and spare a ton of lives. Nevertheless, for a reason, that could be money related or political, putting tech in certain spaces is yet viewed as unassuming whenever contrasted with the significance of these territories of research. A case of such space is the land mine recognition. Up to this date and as per Landmine and Cluster Munitions Monitor report in 2014 [1], it is assessed to have in excess of 110 million land mines in the ground dissipated in 68 nations. An equivalent or might be bigger number is hanging tight to be planted.

The non-insignificant truth about a mine is the distinction in expense between delivering it which is as meager as 3$ and expelling it which is as much as 1000$ [2]. Then again, the hazard went with their reality ought to be dependably a disturbing certainty to individuals living close to a speculated zone. As indicated by the 'Universal Campaign to Ban Landmines organize', in excess of 4,200 individuals, of whom 42% are youngsters, have been falling injured individual to landmines. Other than direct damage for people, mines deny people from the utilization and abuse of significant land assets, for example, ripe grounds for farming or any use. In Cambodia, roughly 40% of the rice fields have mined and deserted [3].

Generally, demining an accomplished for military or helpful purposes. The previous goal is to open a protected entry for troops and vehicles and not to clean the entire zone. Consequently, a specific dimension of misfortune is decent. While in the last mentioned, the objective is fully clean a given territory of land from any presumed article that will represent a hazard on the lives of regular people living around that land space, including inquisitive youngsters.

A great deal of research has now done in the space of mine location, separating and demining. Sensor innovation, ground-entering radar (GPR), electromagnetic enlistment (EMI), atomic quadruple reverberation (NQR) and numerous others are instances of research done around there [4]. For every one of these innovations, discovery is most likely done by master people (identifiers) holding a finder to examine an associated zone with land. This procedure presents a staggering expense as far as time, cash and labour.

A correlation between the significance of location landmines and the endeavours that have sent to mechanize the procedure and to alleviate the human finders from this exceedingly perilous work will demonstrate the absence of innovation required around there of research. Therefore, we went to the target of our undertaking, which is to plan and actualize a robotized correspondences framework for the land mine recognition. The framework for most part made out of a focal unit that will give a remote passage association with another little unit that we will call Robo-pi. This last should supplant the human finder to do the mission consequently and send information to the focal unit for later examining.

2. RELATED WORK

We can sort mines into three distinct classes: people killing mines APMs, hostile to tank mines ATMs and unexploded statutes UXOs. APMs are for the most part of little sizes, light weight between 2-3 kilos, yet can make high harm human whenever exploded. They as a rule contain few metal structures joined with plastic. ATMs in their turn are creating to explode overwhelming weight vehicles like tanks and military caravans. They are huge in size, their loads are between 10-15 kilos and for the most part comprise of metals. The third kinds, UXOs are the unexploded bombs or projectiles, ammunition or whatever other structure that detonates. They do not have comparable highlights since they are a blend of different sorts of components [5].

Albeit the vast majority of the current mines contain a metal part that distinguishes them by means of a metal

identifier, as of late planted mines and a piece of the effectively existing ones are very much canvassed in a plastic encompass that will render the procedure of discovery so mind boggling.

As it is referred to now, conventional mine discovery procedure as it's as yet being done in numerous spots far and wide, has a load of burdens. By utilizing close to conventional metal identifiers, this procedure imperils the life of people on field. Additionally, it takes a great deal of time because of wellbeing issues that should make human identifiers move gradually. That would mean a great deal of dawdled and tremendous time to complete little regions, notwithstanding the need of a major labour to complete the littlest of zones.

Everywhere throughout the world, there is a ton of analysts taking a shot at mine recognition procedures. They centre on finding and concocting new methods utilizing innovations that make mine recognition simpler and quicker than customary metal indicators. There are continuous examines on many detecting strategies including ground infiltrating radar (GPR), electromagnetic acceptance (EMI), atomic quadruple reverberation (NQR) Infrared identifiers (IR), Ultrasound and furthermore Explosives vapour identification (EVD) [4,6]. Mechanical autonomy and remote correspondence to move information to a server are the areas with the fewer pieces of existing proficient related works, particularly on the off chance that we will think about the fast headway accomplished in these spaces and that ought to be connecting in a territory of research that is as significant as mine identification. A few articles could be found in the writing survey, for example, the methodologies exhibited in [7, 8]. A large portion of them utilizes a conventional microcontroller to control the moving location vehicle. This could be fitting for a restricted degree that is just worried about a basic metal indicator and sending few pictures to the focal unit. Vinay D R [9] explains about image capture based on some texture feature and it help us to recognize easily. The image to be ex By the by, when the identification unit should be smart to take choices and furthermore to interface increasingly created types of gear to it, for example, created locators or cameras, microcontroller will be a blocking stone despite improving the proposed venture. At the end of the day, a machine that is as ground breaking as a genuine PC expected to control the unit. Nevertheless, the heaviness of a genuine PC is not acknowledged for utilized in such setting. Furthermore, its cost will dependably be an issue when the unit harmed and should supplant. Vinay D R [10] helps us to recognize metals as objects using background subtraction algorithm. Raspberry Pi would be the best very much fit arrangement as we will see later in this article.

3. SYSTEM ARCHITECTURE

The framework illustrated in Figure1 will be for most part made out of a focal unit that is mindful of accepting data, and a moving Robo-pi unit for distinguishing, information gathering and moving to the focal unit. This last is the robotized locator that should supplant human finders. It is executed with as ease as conceivable to render its substitution reasonable if there should be an occurrence of an unexpected

blast due to undetected mine[11]. Human indicators this situation goes about as guides to control the unit. This will ensure a high decrease of hazard on their lives. Robo-pi unit will discuss remote with the focal unit to send the recognized data when gathering them. This will guarantee the accepting of every fundamental datum even if there should arise an occurrence of losing the unit. Data moved is normally the area of each recognized speculated item and pictures from that area.
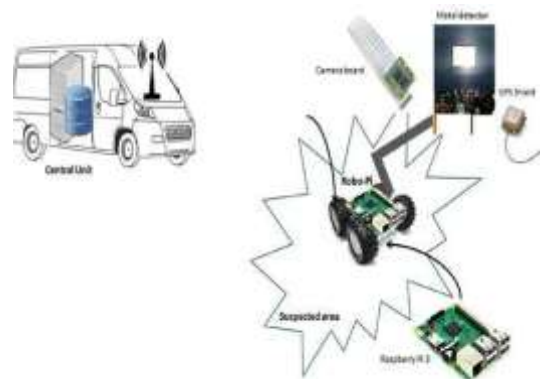

Figure1. System Architecture

A rundown of the utilization cases focused in the proposed framework appeared inFigure2. For privacy, framework access ought to require qualifications for information security and classification. This will be finished by permitting just approved warriors or philanthropic indicators to control the framework [12].
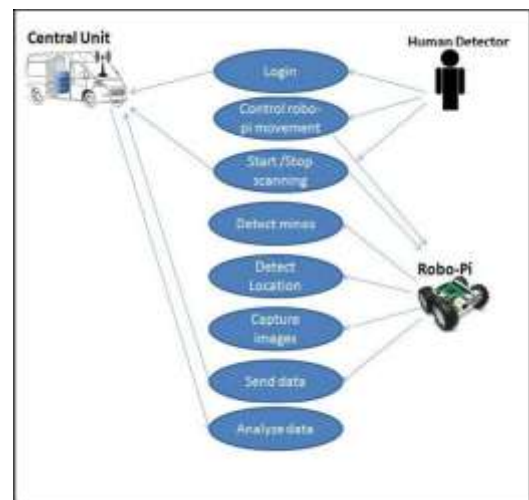

Figure2. Usecase Diagram

4. SYSTEM DESIGN

Laptop unit will establish communication wirelessly using zig-bee protocal with the renisis rl32 microcontroller unit (serial communication)using IDLE(PYTHON),communicate wirelessly with raspberry pi model using putty in windows. In raspberry pi have a metal detector (proximity sensor) includes a coil of wire recognized as the transmitter coil. When electrical energy flows on the coil, a magnetic field is

formed all around it. As you flounce the detector over the land, will create the magnetic field go around too. If you move the detector above a metal object, the moving magnetic fields influence the atoms within the metal. In fact, it changes the way the electrons (tiny particles "orbiting" around those atoms) move. Now if we have a changing magnetic field in the metal, the ghost of James Clerk Maxwell tells us we must also have an electric current moving in there too. In other words, the metal detector creates (or "induces") some electrical activity in the metal. But then Maxwell tells us something else interesting too. If we have electricity moving in a piece of metal, it must create some magnetism as well. So, when you move a metal detector over a piece of metal, the magnetic field coming from the detector causes another magnetic field to appear around the metal.
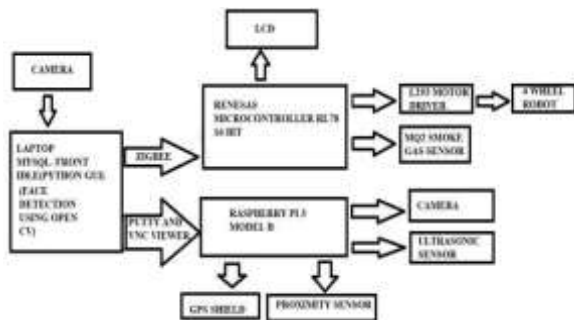

Figure3. Proposed Framework Design

You move the detector over the metal, electricity flows through the receiver coil, making the loudspeaker click or beep. The closer you move the transmitter coil to the piece of metal, the stronger the magnetic field the transmitter coil creates in it, the stronger the magnetic field the metal creates in the receiver coil. Robo-unit is composed of a vehicle equipped with a Renesas Electronics RL78 16-bit Microcontrollers as its brain, to control the robo-unit and a raspberry pi b mobel with a metal detector, ultrasonic sensor, gps module, camera that are all connected and managed by the raspberry pie, when ever a landmine is detected it will capture the image and send the gps location of the landmine to the authorized email. We have gas sensor in rl78 which detects gas .Since mines usually explode whenever they detect the weight they are designed for, and although we have chosen the component of our Robo-Pi unit to be as light- weight as possible, but its passage over the mine before detecting it will expose it to high risk.

5. IMPLEMENTATION TOOLS AND ITS USES

OpenCV-Python is the python API for OpenCV. You can think of it as a python wrapper around the C++ implementation of OpenCV. OpenCV-Python is not only fast (since the background consists of code written in C/C++) but is also easy to code and deploy (due to the Python wrapper in foreground). This makes it a great choice to perform computationally intensive programs

5.1 Mine Indicator

The mine indicator to be utilized on the Robo-Pi could be any kind of sensors: metal identifiers, Infrared imaging, Ground Penetrating Radar (GPR), ultrasonic radars, microwave sensor. For effortlessness, cost and accessibility of hardware, we picked the metal indicator to be our sensor. However, the equivalent is relevant to some other kind of sensors if an association bears to purchase costly sensors or radars, anyway we picked a metal finder to be utilized in this venture since the majority of the current mines particularly the old ones (such like the ones in Lebanon) contain ordinarily a metal pieces to be recognized. Moreover, large portions of the current recognition techniques are yet dependent on the metal sensors. Nevertheless, the model that we are displaying in this article, can acknowledge with slight adjustments some other kind of locators.

Our server-side web application contains a primer picture handling code that we executed in the target of attempting this created and required usefulness for future reconciliation into the framework. This choice takes the picture caught by the camera, and afterward thinks about its similitude to recently spared pictures of mines. After correlation, we characterize the base adequate comparability rate to choose if this is a mine or not in view of the officially spared pictures.

Since mines ordinarily detonate at whatever point they recognize the weight they are intended for, and in spite of the fact that we have picked the part of our Robo-Pi unit to be as light-weight as could be allowed, yet its entry over the mine before identifying it will open it to high hazard. Consequently, metal identifier is fixed on the base of a plastic arm that is joined to the side of the vehicle to distinguish the mine before the entry to its area. The GPS shield is additionally connected on the highest point of the arm so the area of the distinguished article is the thing that to be sent to the focal unit and not that of the vehicle.

5.2 Metal Locator

It is a circuit with a solitary transistor and old pocket radio. This is only a Colpitts oscillator working in the medium band recurrence and a radio tuned to a similar recurrence. At the point when this circuit is set close to a metal item, the inductance of its curl and furthermore the recurrence of motions will change. Subsequently, the distinction in the two frequencies would not permit the dropping of sound and the metal will be identified. This method of working enables the utilized metal identifier to identify objects without the need of direct contact to them. Henceforth, not just metal articles laid on the ground will be identified, conversely, recognizing covered components in a profundity of 10 to 15cm from the beginning will be conceivable too.

5.3 Haar Cascade Classifier

It employs a machine learning approach for visual object detection which is capable of processing images extremely

rapidly and achieving high detection rates. It is a machine learning based methodology where a cascade method is prepared from a great deal of positive and negative pictures. It is then used to recognize protests in different pictures.

Face identification is a major area where will work on. At first, the calculation needs a great deal of positive (pictures of appearances) and negative (pictures without countenances) to prepare the classifier. At that point we have to concentrate highlights from it. For this, haar highlights appeared underneath picture are utilized. They are much the same as our convolution bit. Each element is a solitary worth gotten by subtracting entirety of pixels under white square shape from total of pixels under dark square shape. This can be attributed to three main reasons
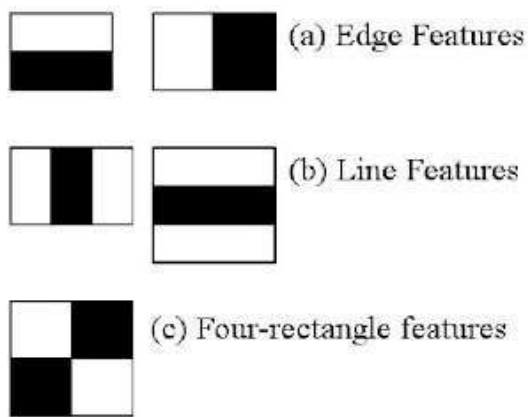

Figure4. Detecting face by haar cascade classifier

Presently all potential sizes and areas of every bit is utilized to ascertain a lot of features. For each component computation, we must discover whole of pixels under white and dark square shapes. To explain this, they presented the fundamental pictures. It rearranges estimation of entirety of pixels, how huge might be the quantity of pixels, to a task including only four pixels.

The cascade classifier work includes two noteworthy stages: preparing and recognition. Identification stage is portrayed in a documentation of object detect module of general Open CV documentation. Documentation gives some essential data on cascade classifier. Current path is depicting how to prepare a cascade classifier which includes planning information and running the trained application. The system will be mainly composed of a laptop unit that is responsible of face recognition using image processing open cv, and a moving 4 wheel robot-unit with L293D motor driver, IC MAX 232 (in case of wired communication).Haarclassifier employs 'Integral Image' concept which allows the features used by the detector to be computed very quickly

5.4 AdaBoost

The learning algorithm is based on **AdaBoost**. It chooses a small number of significant features by a bulky set and gives tremendously well-organized classifiers. AdaBoost classifier consolidates feeble classifier calculation to frame solid classifier. A solitary calculation may order the articles ineffectively. In any case, on the off chance that we join numerous classifiers with choice of preparing set at each emphasis and doling out perfect measure of weight in definite casting a ballot, we can have great precision score for in general classifier.

1. Retrains the calculation iteratively by picking the preparation set dependent on exactness of past preparing.
2. The weightage of every prepared classifier at any cycle relies upon the exactness accomplished.

More complex classifiers are combined to form a 'cascade' which discard any non-face regions in an image, thereby spending more computation on promising object-like regions.

5.5 ZigBee

A ZigBee system works on a solitary recurrence channel. While it is conceivable to reconfigure the total organization to convey at an alternate recurrence, the system does not channel bounce and is subsequently inclined with the impacts of outer impedance and multi path blurring featured previously. Each layer speaks with the adjoining layers through administration passageways known as service access point and is a theoretical area at which one convention layer can demand the administrations of another convention layer

5.6 Raspberry Pi 3 Model B

The Raspberry Pi 3 Model B is a little credit card estimate PC. Simply include a console, mouse, display, power supply, smaller scale SD card with introduced Linux Distribution and have a completely fledged PC that can run applications from word processors and spreadsheets to recreations. The Raspberry Pi3 Model B is the third era Raspberry Pi. This amazing charge card measured single board PC can be utilized for some applications and supplants the first Raspberry Pi Model B+ and Raspberry Pi 2 Model B. VNC is the place you can see the screen of the other PC on yours, where PuTTY is for things like SSH, where you sign in utilizing an order line interface. Putty is a SSH customer that you can use to associate with a machine running that administration and moderately secure however you just have a CLI and no GUI. VNC resembles a the Windows Remote Desktop highlight where you can really observe the work area condition on which you are working - the host machine should run a Xvnc server to make a virtual work area (more often than not on port 5901) and you interface through the VNC customer on the visitor machine. The issue with this is it is moderately asset overwhelming and gobbles up a generous segment of data transfer capacity (arrange ward obviously). What I do when I have to really observe my work area will open up a SSH session and after that utilization VNC to interface by means of that safe session

6. RESULTS AND SIMULATION.

All the simulations were performed on an Intel Core i3-2328 with 2.20 GHz CPU and 4 GB RAM running on the platform Microsoft Windows 10 pro. We have used MATLAB for the simulation purpose. In the MATLAB we have categorized the identification of landmine into three classes i.e. class A -no landmine data, class B-anti-personal landmine data ,class C-anti-tank landmine data based on neural network simulation with machine learning with the help of machine learning we categorized the landmine detection ,this method is 100% efficient with zero rate of errors while identifying the type of landmine compared to other methods .fig 5 tells about the samples of data taken and processed using neural network
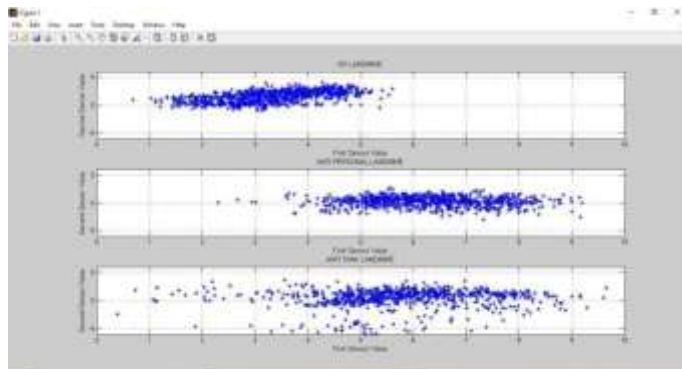

Fig5.2D plot of Samples of data w.r.t no landmine, anti-personnel and anti-tank landmine in MATLAB

A neural network is a progression of calculations that attempts to perceive hidden connections in a lot of information through a procedure that impersonates the way the human cerebrum works. Neural network can adjust to evolving input; so, the system creates the most ideal outcome without expecting to update the yield criteria. The Neural Network is built from 3 kind of layers Information layer (input layer) — introductory information for the neural system, Concealed layers (hidden layer) — moderate layer among info and yield layer and spot where'll the calculation is finished. Yield layer (output layer) — produce the outcome for given data sources as shown in fig
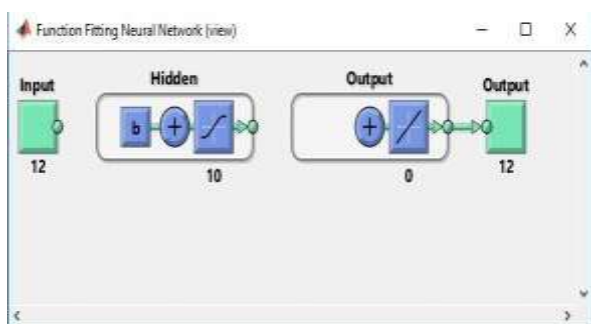

Fig6 .neural network layers represented in MATLAB

using MATLAB simulation i.e. using neural network is 100% efficient with zero rate of error we can identity the type of landmine efficiently in fig7.
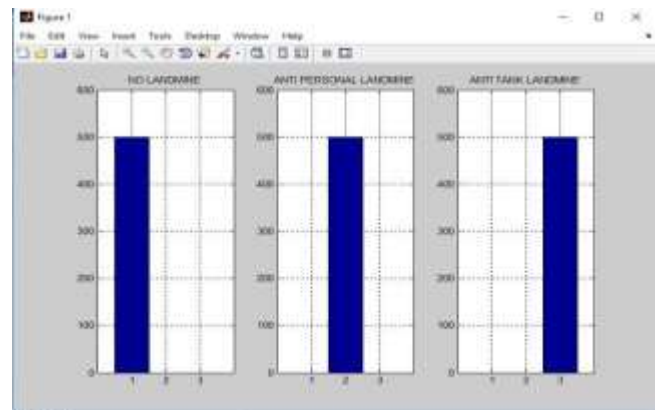

Fig7.identifcation of landmine based on classes with zero rate of error

7. CONCLUSION

Lind mine reality is one of the primary worries that Impedes the recovery of the ordinary life parameters after war to numerous nations and districts. Identification procedure of these mines more often than not takes a great deal of time and exertion and subsequently, it is normally failing to the last advance of need levels. The target of this undertaking was to plan and actualize an effective ease and little size programmed land mine locator. This identifier depends on a Raspberry Pi minicomputer deliver that will go about as the cerebrum of a little robot to consequently recognize and move the data about any discovered metal item to a focal unit. The discovery procedure that is utilizing depends on a metal indicator that can recognize metal items even with no immediate contact with them and regardless of whether they are covered around profundity. Tests have done to identify metal items on various zones of grounds and the identifier could move the required data, for example, the accurate area of the articles and the pictures of the zone where the item found with awesome exactness. The proposed Robo-pi unit can consider as a model that still need genuine tests to demonstrate its proficiency

REFERENCES

1. Cluster Munition Monitor 2014, http://archives.themonitor.org/index.php/LM/OurResearch Product/CMM14, Aug 27 [Mar.30, 2017].
2. Alaa Khamis "Mines weepers: Facts about landmines, Internet: http://www.landminefree.org/2016/index.php/support/facts-about landmines", Oct. 30 2016 [Mar. 30, 2017].
3. A. Mahmoud and H. Farouk, "An Efficient Detection and Classification Method for Landmine Types Based on IR Images Using Neural Network", International Journal of Geology, Vol.4 iss. 4, 2010.
4. L. Robledo, M. Carrasco, and D. Mery, "A survey of land mine detection technology", International Journal of Remote Sensing, Vol. 30, Iss. 9, 2009.

5. P. Rapillard and M. Walton, "Humanitarian and Developmental Impact of Anti-vehicle Mines", Journal of Conventional Weapons Destruction, Vol. 18, Iss. 3, 2014.

6. M.Kale, V.Ratnaparkhe and A.Bhalchandra, "Sensors for Landmine Detection and Techniques: A Review", International Journal of Engineering Research & Technology, Vol.2, Iss.1, 2013.

7. A. Patri, A. Nayak and S. Jayanthu, "Wireless Communication Systems for Underground Mines – A Critical Appraisal ", International Journal of Engineering Trends and Technology (IJETT),Vol.4, Iss. 7, 2013.

8. Facts about Land mines Publication Info (2010, 3, 16) [Online]. Available: http://www.care.org/emergencies/facts- about-land mines.

9. Vinay D R, N Lohithesh Kumar, "Acquisition of Images using Neural Network", Published in IJRITC international journal,vol,3,issue 1,may 2015 edition.

10. Vinay D R, N Lohithesh Kumar, "Object Tracking using Background Subtraction Algorithm", Published in IJERGS international journal,vol,3,issue 1,2015 edition.

11. J.N. Murphy, H.E. Parkinson, "Underground Mine Communication", Proceedings of the IEEE, vol. 66, January 1978.

12. W. H. Schiffbauer and J. F. Brune, "Underground coal mine communications for emergencies and everyday operation," Symposium on the Capabilities and Availability of Wireless Communication and Tracking Systems for Underground Coal Mines, Feb.13, 2006.