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TECHNOLOGY APPLICATIONS TEAM

Quarterly Progress Report

IITRI Project V6102

NASA Contract NASw-1953

for the period

1 October to 31 December 1969

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I. INTRODUCTION

TECHNOLOGY APPLICATIONS TEAM

Quarterly Progress Report

IITRI Project V6102

for the period

1 October to 31 December 1969

I. INTRODUCTION

The Technology Utilization Program of the National Aeronautics and Space Administration has been actively engaged in transferring into the Public Sector new technology which was developed originally for aerospace applications. In order to foster this process, NASA has developed the concept of a Technology Applications Team whose task is to act as a catalyst in bringing together the expertise that resides in NASA and the technical needs of the Public Sector.

This is the second quarterly report of the work of the TATeam at IIT Research Institute. The IITRI team is concerned with problems in the field of Law Enforcement, Mine Safety, and at the end of this quarter has added a third area, Water Pollution. This report details the activities of the team during the months of October, November, and December. The following section presents an overview of the project. Section II discusses the public sector contacts the team has made, the aerospace literature searches conducted, and the relevant technology identified during this time period.

II. PROJECT OVERVIEW

II. PROJECT OVERVIEW

The Technology Applications Team program is an experimental one in which an attempt is being made to gain an understanding of the process of technology transfer. The basic methodology of the project was outlined in the first quarterly report but each detailed step is being evaluated as the project moves on.

The main objective, of course, is the transfer of aerospace technology, particularly that generated by NASA and its contractors, into the Public Sector. This technology has been paid for by the American people and it is a mandate of the Space Act of 1958 that it be made publicly available. Meanwhile, a number of problem areas have recently become of great concern to the general public - areas for which there is a pressing need for new technology. The IITRI team has focused its attention on problems in Law Enforcement and Mine Safety. In the coming months it will add Water Pollution as an area of concern.

The team acts as a catalyst in applying scientific and engineering developments created for aerospace functions to quite different functions in the public sector. One of the key elements in this process is communication between the two communities. We have learned that one of the principle reasons that technology has been slow to make its way into these areas is that scientists and engineers fail to understand the problems faced by people in the public sector. It is more than just a language barrier; engineers and, say, police officers think and operate differently. As a result, an engineer who thinks he has an ideal device for law enforcement use, based on his preconceived notions of a problem, finds his ideas rejected by the police because they are not practicable to the way the police must function.

The team, then, spent the first few months of the program in building relationships with the mining and law enforcement communities which would permit that necessary communication. We have found that the more informal these relationships could be, the better the chance of arriving at an exact definition of the problem.

Once a problem is defined, it is the task of the team to break it down into the scientific parameters which can be grasped by the aerospace researchers. This is done in a written problem statement which contains a brief description of the problem, a listing of the applicable physical parameters, suggested approaches to a solution, and background information to provide a better understanding of the needs involved. This written statement is send to NASA Field Centers for distribution to persons thought to have relevant technical background. At the same time, a computerized literature search is performed by the team at one of NASA's Regional Dissemination Centers.

While the major effort during the first half of the program has been involved in establishing the relationships which are so important to the transfer process, a number of problems in both Law Enforcement and Mine Safety have been defined, and in some instances some relevant technology items which represent important potential transfers have been identified. These will be described in detail in the following section.

III. SECOND QUARTER ACTIVITIES

III. SECOND QUARTER ACTIVITIES

This section describes the activities of the IITRI Technology Applications Team during the period October 1 to December 31, 1969. Contacts the team has made with mining and law enforcement personnel are discussed first. The following sub-section describes the problem statements which have been prepared during the period. Next, a description of the literature searches performed by the team is given. Finally, the technology identified and the transfer potential of each item is discussed.

A. Agency Contacts

Date: 20 October 1969

Agency: Chicago Police Department

Persons Interviewed: Miss Maureen Casey, Documents Lab, and Mr. Ernest Warner, Firearms Identification Lab

Team Members Present: F. R. Hand, S. Uccetta, J. Weyer, and K. Kamath

Miss Casey described for us the problem of reconstructing the intelligence in indented writing and that of determining the age of sequence of writing done with a ball pen. The information obtained during this interview was incorporated into Problem Statements LE-2 and LE-4.

Mr. Warner described the process now used to identify a weapon from which a given bullet was fired. A comparison microscope is used to compare the evidence bullet with a test bullet fired from the same gun. The primary need is for a system which will reduce the time involved in making the comparisons. (This problem involves a complete analysis system and does not appear to be amenable to applications team study at this time).

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Date: 3 October 1969

Agency: Law Enforcement Assistance Administration

Persons Interviewed: Mr. C. H. Rogovin, Administrator, Mr. R. W. Velde, Associate Administrator, Mr. H. Ruth, Director of Law Enforcement Institute, Mr. A. Karp, Institute Staff member.

NASA Personnel Present: Mr. M. Day, Mr. R. Philips, Mr. R. Bivins, TUD, and Mr. G. D. Ginter, OART.

Team Members Present: F. R. Hand and W. McMahon

The purpose of this meeting was to clarify for LEAA the role NASA can play in assisting the law enforcement community in obtaining new technology. The discussion resulted in an agreement of support from LEAA for the applications teams program. This was to be verified by exchange of letters between Mr. Day and Mr. Ruth. The contact person within LEAA was to be designated. (Mr. Karp was later designated to work with the team. See meeting of 21 November).

- - - -

Date: 27 October 1969

Agency: U. S. Post Office, Bureau of Postal Inspection

Persons Interviewed: William Cotter, Chief Postal Inspector

Team Members Present: William McMahon

Chief Cotter was briefed on the purpose and methodology of the Applications Team program, and was asked of his bureau's interest in pursuing some of their security problems with the team. He indicated his interest and said he would discuss with his staff the best way to arrange discussions of specific problems. No problems were considered at this meeting. Mr. Cotter will contact the team when ready to discuss certain problems.

- - - -

Date: 31 October 1969

Agency: Maryland Governor's Commission on Law Enforcement, Maryland State Police

Persons Interviewed: R. M. Gutekunst, Acting Director, J. R. Donovan, Director of Data Systems Development, Governor's Commission; Col. R. J. Lally, Supt., Capt. H. M. Everline, Chief of Planning and Research, Mr. Blair Shirk, Director of Data Processing, State Police.

Team Members Present: F. R. Hand, W. McMahon, IITRI; R. G. Bivins, NASA

Mr. Bivins briefed the group on the objectives and scope of the Applications Team project. The main objective was to develop an understanding with the Commission of the kind of problem the team would undertake to study. They are in their early stages of operation and were not able to give us a shopping list of problems at that time. They will be helpful in steering us to those local agencies in Maryland who can define specific problems.

A cooperative atmosphere was established between both the Governor's Commission and the State Police. The only problem to be suggested at this meeting was mentioned by Mr. Shirk. His department has seen a need for means for locating faults in a data communications link. He and Mr. McMahon agreed to meet in December to obtain the information needed to prepare a problem statement.

- - - -

Date: 14 November 1969

Agency: U. S. Bureau of Mines

Persons Interviewed: Dr. Thomas Howard, Director of Research

Team Members Present: Dr. Madan M. Singh

Dr. Howard was brought up to date on the work that the team has done on mine safety problems. He was quite interested in the results uncovered so far. Dr. Singh described the dust monitor developed by ERC and the use of lasers to replace conventional optics, such as in a Tyndalloscope.

Dr. Howard indicated that work of this nature was being carried out at the Pittsburgh laboratories. An earlier conversation with Dr. W. Courtney, at the Pittsburgh laboratory, found that this work did not involve the use of lasers. The limitations of optical methods of dust measurement (e.g., differences of index of refraction of rock dust and coal dust) were discussed. Dr. Singh pointed out that any recommendations made for the implementation of this technology would take these limitations into account.

At an earlier meeting, in August, Dr. Howard volunteered to call together the directors of the Bureau's various research centers to meet with our team for a presentation of our project and discussion of some of their technical problems. He indicated that this meeting will be held in Denver around the middle of January and that they would reserve half a day for our presentation. We will be informed later of the exact date for this meeting .

- - - -

Date: 14 November 1969

Agency: National Academy of Engineering, Committee on Mine Rescue and Survival Techniques

Persons Interviewed: Mr. Gerald Meloy, Executive Secretary

Team Members Present: Dr. Madan M. Singh

The discussion centered around the problem statements prepared by the team and which had been sent to Mr. Meloy by F. R. Hand. Mr. Meloy had discussed these statements a few days earlier with Dr. Clingman. He felt that they had been well written and expressed the problems adequately.

Mr. Meloy also said that he would like to include the latest results of our work in his final report which will be in preparation in January. He was most keenly interested in the two problems on explosion quenching, MS-2 and MS-4.

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Date: 21 November 1969

Agency: Law Enforcement Assistance Administration

Persons Interviewed: Abraham Karp, Louis Mayo, Paul Cascarano, and Jay Merrill

Team Members Present: F. R. Hand, W. McMahon, IITRI, and R. G. Bivins, NASA

Mr. Bivins expressed the objectives and scope of the program. Once again it was necessary to develop an understanding of the role of the team and the type of problems it is set up to handle. Mr. Mayo stated that in a few weeks, date undetermined, the LEAA would publish its priorities for 1970. They were not yet in a position to give us a shopping list of problems but Mr. Mayo would select one or two for us to work on - as a test of the team concept. He pointed out that LEAA is focusing on problems in the criminal justice realm. Traffic and other aspects of law enforcement are the responsibility of other agencies such as the National Highway Safety Board. Mr. Mayo and Mr. McMahon will coordinate on the selection of the above mentioned problems.

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Date: 18 November 1969

Agency: Chicago Fire Department

Persons Interviewed: Captain Maker, et al

Team Members Present: F. R. Hand, (Mrs.) M. Myers, and I. Feldhouse

Captain Maker discussed with us the rescue of injured people from wrecked vehicles. In Chicago, this is the responsibility of the Fire Department, especially Snorkel Squad No. 1. They showed us some of the tools used in removing and prying apart metal parts of autos and trucks which have the occupants pinned inside.

Their main problem is in the removal of the metal. They use power saws, hack saws, torches, and sometimes special hard bladed axes. The main concern is the fire hazard associated with spilled gasoline or other flammable materials. They keep extinguishers handy and often spray water to protect the occupants when torches are used.

Also needed are special tools to pry apart metal sections, such as cowl and frame, which have collapsed to within a few inches of each other. Most jacks, which are used for this purpose, are too large to be inserted in this space.

The complete apparatus of the Snorkel Unit was not available at the time of our visit and we were invited back to see that at a later time. This unit, which handles most of the rescue work in Chicago (about 20 calls a day) is considered one of the most complete in the nation.

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Date: 8 December 1969

Agency: Chicago Police Department, Crime Laboratory

Person Interviewed: Miss Maureen Casey, Chief of Documents Section

Team Member Present: F. R. Hand

Miss Casey was presented with a copy of our problem statement, LE-2, Detection and Recovery of Indented Writing, for her review. Mr. Hand also briefed her on two items of technology already located through search of NASA and AEC Tech Briefs. One concerned a fiber optic surface gage which had been incorporated into an automatic instrument for inspecting tube flares. The other was an adaptation of a mechanical surface profilometer. We discussed the application of these ideas to the indented writing problem. This discussion brought out several points concerning the cost-effectiveness of a system to perform the task of reading indented writing. This information will be very valuable in evaluating further technology uncovered by the formal literature search.

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Date: 17 December 1969

Agency: Maryland State Police

Person Interviewed: Mr. Blair Shirk, Director of Data Processing

Team Member Present: W. McMahon

Mr. Shirk described the problem of locating trouble in computer communication links between terminal facilities. Currently, when an outage occurs, it is necessary to manually trace the fault, resulting in excessive down-time. Loss of the computer for long times is intolerable and greatly impairs the effectiveness of the system, which is connected to the National Crime Information Center operated by the FBI. Mr. Shirk wondered if there are automatic trouble shooting techniques employed by NASA which could be applied to this problem. As a result of this discussion, a problem statement will be prepared by Mr. McMahon.

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Date: 29 December 1969

Agency: Maryland State Police

Person Interviewed: Captain Hugh Everline, Chief of Planning and Research

Team Member Present: W. McMahon

Captain Everline indicated a great interest in being able to monitor vehicle speed in real time from a moving patrol car. His particular interest centered around the analysis of traffic flow. They use the VASCAR system at present because it eliminates the need for stationary sites, but object to the need for the officer to make certain critical judgements of time and distance.

Captain Everline also expressed an interest in the problem of improved methods of extracting victims from vehicle wreckage. They currently must call a private wrecking crew and wait for it to arrive at the scene before assistance can be given to trapped victims. If they had some simple-to-use method or equipment of their own, they could render assistance as soon as the patrol

arrives at the scene, thus improving the chances of saving lives. (This concern lends importance to Problem Statement LE-9, now in preparation).

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Telephone conversations were held with Mr. H. Schub, Research Chemist with Fisher Pen Company, and Mr. Linton Godown, Consulting Document Examiner, concerning the problem of determining age of inks. Fisher is one of the principle ink manufacturers. Both offered to comment on our problem statement and to assist in obtaining information on the properties of inks.

As indicated above, team representatives will meet with research directors of the Bureau of Mines to present our program and what has been achieved to date. We hope that as a result of this meeting, some additional problems will be forth coming for the Mine Safety area. Additionally, the team will meet in January with the New York State Office of Crime Control, the criminal justice planning agency, and the New York City Police Department. These meetings should also bring to light some new problems.

B. Problem Statement Preparation

Most of the problems on which the TATeam is focusing its attention currently were identified during the first quarter. A great deal of effort and discussion has occurred since then in developing a satisfactory format for the Problem Statements. The Problem Statement is intended to (1) convey all pertinent information about a problem, (2) be motivational in eliciting technical ideas from NASA scientists and engineers.

The format arrived at by the IITRI team consists of the following outline:

1. Introduction - Presents the reader with the social impact the problem has generated, and the technical importance of arriving at a solution.

2. Statement of the Problem - A concise statement of the technical needs of the problem, followed by a list of the essential characteristics and constraints associated with the application.

3. Possible Approaches - A list of the physical properties which might be exploited in arriving at a solution.

4. Background Information - Contains details about the problem, methods of solution already being tried and their limitations, and any other information needed to complete the picture.

5. References - A list of references already acquired through the literature search, if the search is completed prior to sending out the Problem Statement.

6. For Further Information - The name, address, and telephone number of the team representative to contact if additional information is required, or if one wishes to discuss possible solutions to the problem.

Their format was developed in lieu of the final results of a project conducted by Dr. William Clingman, W. H. Clingman & Associates, under a separate contract, to develop guidelines for Problem Statement preparation. We have had discussions with Dr. Clingman which have been helpful in arriving at the above format and in improving the content of the Problem Statements we have to date prepared.

In trying to develop a style which would be attractive to the NASA engineer, we felt that a distinctive cover sheet should be used with each document. The cover should (1) draw attention, (2) identify the originator as one of the Technology Applications Teams, (3) convey the subject of the problem, and (4) indicate the NASA authority for the TATeam program. The design agreed on by all teams and TUD program monitor contains the words TECHNOLOGY APPLICATIONS TEAM, the NASA logo, and instructional paragraph indicating the purpose of the program and the manner in which a reader should respond.

The cover sheets are printed with this information placed in a pleasing, easy-to-read arrangement. A light blue color is used as an eye catching device. The cover sheet was adopted at a meeting of all TATeams in November.

The Problem Statements which were placed in their final form and distributed to NASA research centers during this quarter are shown in the following pages. These are:

MS-4, Quenching of Coal Mine Explosions
MS-5, Mine Rescue Communications
LE-2, Detection and Recovery of Indented Writing
LE-3, Vehiclar Speed Determination
LE-4, Age and Sequence of Ball Pen Inks on Documents with Multiple Writing

In addition, draft problem statements were prepared for the following problems:

MS-6, Improved Batteries for Underground Coal Mines
LE-1, Omni-directional Antenna for Portable Police Transceivers
LE-5, Remote Medical Measurements
LE-6, Miniature TV System for Vehicle Surveillance
LE-7, Lightweight Gas Mask and Face Protector
LE-9, Improved Rescue Equipment

TECHNOLOGY
APPLICATIONS
TEAM

QUENCHING OF COAL MINE EXPLOSIONS

A problem in Mine Safety undertaken by the
IIT Research Institute team sponsored by
NASA's Technology Utilization Division

This Problem Statement calls to your attention significant technological needs in an important area of concern in the public sector. We hope to bring to bear on this problem the information and expertise that resides in NASA. If you feel you can contribute, please relate your ideas to the Technology Utilization Officer at your installation, or to the team representative named in the statement.

INTRODUCTION

A coal mine explosion takes a finite time (measurable in milliseconds) to develop. Within this millisecond time period, a suitable quenching or suppression agent could be discharged into the appropriate area to completely contain the explosion. Discharge of the quenching or suppressing agents would be automatically triggered by sensing devices which receive the signal from the initiating explosion.

STATEMENT OF THE PROBLEM

The coal mining industry needs an explosion quencher-suppressor capable of discharging into the explosion front preferably within 40 milliseconds. A satisfactory agent would meet the following criteria:

1. Non-toxic.
2. Capable of being dispersed uniformly in a coal mine passage.
3. Dispersion technique to be used should not, in itself, constitute a hazard.
4. Able to suppress either methane or coal dust explosions.

POSSIBLE APPROACHES

The suppression of a combustion process can occur when one or more of the three constituents of the process--namely, fuel, oxygen, and temperature--are reduced to a point where the combustion cannot be sustained.

The U.S. Bureau of Mines has experimented successfully with bicarbonate powder in arresting coal dust explosions. However, the dispersion technique used (exploding a "bomb" of the agent to swamp the explosion front) can cause injury to miners in the vicinity. Hence, an improved dispersion technique

using this agent would also contribute significantly in solving this problem.

BACKGROUND INFORMATION

The majority of coal mine explosions are initiated and/or propagated by either methane gas, coal dust, or a combination of the two.

Methane

The presence of methane gas in coal mines is due to the decomposition process which has formed the coal itself. At concentrations of methane in air above 15% and below 5%, an explosion will not occur. The methane level is controlled in most mines by forced ventilation, but this is not always successful in preventing accumulation in pockets or unused areas of the mine, or at the working face.

The ignition temperature limits of the gas range from a low of about 565°C (1050°F) to a high of 810°C (1380°F) and the gas has a flame temperature of approximately 1875°C (3410°F).

Coal Dust

The explosive hazards of coal dusts are determined by their composition, concentration, particle size, and particle size distribution. The minimum concentration at which coal dust in air can explode is about 35 gm/m^3*, assuming an average particle diameter of 3 . Particles larger than 850 (20 mesh) are not involved in explosions. The ignition temperature of coal dust is about 900°C (1650°F) and the dust explosion could be initiated by a methane gas explosion, exposure to open flames, sparks, and to a limited extent, by spontaneous combustion.

*1 milligram per cu. meter = 1 million particles per cu. foot (MPPCF).

Coal dust explosions are often secondary phenomena, caused by a methane gas explosion, and the resulting damage is due largely to this secondary effect.

CURRENT METHODS

The U.S. Bureau of Mines has developed an explosion detection-quenching device (Ref. 1 and 2) which has successfully arrested coal dust explosions in mine entry areas. The sensor of this device picks up ultraviolet radiations from ignited gas which initiate mine explosions and then triggers the quencher. The latter, essentially a tubular "bomb" of potassium bicarbonate, explodes and swamps the path of the explosion front with noncombustible potassium bicarbonate and carbon dioxide, a decomposition product.

The device is still under further development and has the major drawback of responding to spurious ultraviolet signals causing false detonations of the quencher. This can cause injury or impairment of hearing to miners working in the area. Hence, the system has not gained acceptance in the mining industry.

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2. Kamenski, E. M., Nagy, J., Conn, J. W., "Further Development of an Explosion Quenching Device," to be presented at Int. Conf. of Safety in Mines Research, Tokyo, Nov. 20-25, 1969.

A literature search of aerospace technology is presently being conducted; however, some relevant references may not be identified by this means, and any additional references you may suggest would be appreciated.

FOR FURTHER INFORMATION

Contact: F. R. Hand, Project Director
NASA Technology Applications Team
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10 West 35 Street
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Extension 5281

Reference: IITRI/MS-4

IITRI/MS-5

TECHNOLOGY APPLICATIONS TEAM

MINE RESCUE COMMUNICATIONS

A problem in Mine Safety undertaken by the
IIT Research Institute team sponsored by
NASA's Technology Utilization Division

This Problem Statement calls to your attention significant technological needs in an important area of concern in the public sector. We hope to bring to bear on this problem the information and expertise that resides in NASA. If you feel you can contribute, please relate your ideas to the Technology Utilization Officer at your installation, or to the team representative named in the statement.

INTRODUCTION

Following the occurrence of a mine disaster, rescue efforts are generally hampered by a lack of information regarding survivors who may be trapped within the mine. The efficiency of rescue operations would be greatly improved if trapped personnel could communicate with those on the surface by means of some sort of emergency signalling system. Present communication links, where provided, between the mine interior and the surface generally offer only limited coverage, and are not designed to survive an explosion or collapse.

STATEMENT OF THE PROBLEM

Emergency signalling devices should be readily accessible to everyone within a mine. This objective would best be met by furnishing each person entering a mine with his own signalling unit. Individual units should therefore be small enough to be carried on the person without discomfort or interference with normal work. The following additional requirements should be met by the emergency signalling system:

1. Range should be at least several hundred feet through rock, soil, water, etc.

2. The cost per signalling unit should be reasonably low--say a few dollars.

3. Each unit should be capable of several hours of continuous operation from its own power source. This, in turn, would probably dictate that average power consumption be held under five watts.

4. It would be desirable that each unit be completely self-contained, with no need to attach external antennas, ground leads, sonic transducers, or the like.

POSSIBLE TECHNIQUES

Among possible techniques which appear promising are the following:

1. Mechanical (seismic).

2. Electrical/magnetic--either direct penetration by means of electrical or electromagnetic signals, or by using existing electrical conductors (wiring, rails, pipes, etc.) as signal-carrying media.

BACKGROUND INFORMATION

Following are some brief observations regarding the applicability of various signalling methods.

1. Mechanical (seismic) - The attenuation of mechanical energy as it travels through rock rises rapidly with frequency. Even at frequencies as low as one kilocycle, attenuation of the order of hundreds of decibels for 1000 foot penetration is typical. This will probably eliminate any but sub- and low-audio frequencies from further consideration. It should be noted that, due to the extremely high attenuation coefficient for loose soil, both sending and receiving devices in a seismic signalling system would have to be placed in intimate contact with bedrock. This could be objectionable wherever topsoil thickness is greater than a few feet.

2. Electrical/magnetic - Two general signalling techniques employing electrical/magnetic propagation appear to merit investigation: (a) carrier systems, utilizing existing electrical conductors within the mine (this would include rails, plumbing, ductwork, etc.); and (b) direct penetration techniques, which would radiate energy directly between the mine interior and the surface.

   Relatively high transmission efficiencies might be realized with carrier communication techniques, so that comparatively low transmitted power levels would be required. Increased reliability would be obtained by utilizing all conducting structures in parallel, with frequent cross-connections between different types of structures. This would provide maximum redundancy in available conducting paths.

Based on the principal mode of propagation, direct penetration techniques can be classified as electrical, magnetic, or electromagnetic.

An electrical system, which would depend on the conductivity of the rock and soil between the transmitter and the receiver, would require that a pair of electrodes be driven into the earth at each end of the transmission path. For a given transmitted power, the range achievable with such a system is directly related to the electrode spacings. Further investigation will be required to determine whether adequate range could be obtained with reasonable electrode spacings. Effectiveness of such a system is greatest at low frequencies, so that direct voice transmission would be possible with a minimum of equipment.

In a magnetic system, the transmitter and receiver are provided with induction coils which set up and detect a varying magnetic field. As with an electrical system, propagation efficiency decreases with increasing frequency; however, it is somewhat more difficult to provide for voice communication with a magnetic system.

An electromagnetic system (i.e., radio) operating in the ELF or VLF region would be capable of penetrating to great depths. (The Navy uses low audio frequencies to communicate with submarines which are submerged in sea water.) The primary drawback of such a technique is that, due to the long wavelengths involved, extremely large transmitting antennas are required for truly efficient radiation. Nevertheless further investigation would seem worthwhile.

REFERENCES

A literature search of aerospace technology is presently being conducted. A list of pertinent references so far identified in this search is attached. Any additional references you may suggest would be appreciated.

FOR FURTHER INFORMATION

If you need more details about this problem, or if you wish to discuss some of your ideas with a team representative, please contact:

F. R. Hand, Director
NASA Technology Applications Team
IIT Research Institute
10 West 35 Street
Chicago, Illinois 60616

Telephone: (312) 255-9630
Extension 5281

Reference: MS-5

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IITRI/LE-2

TECHNOLOGY APPLICATIONS TEAM

DETECTION AND RECOVERY OF INDENTED WRITING

A problem in Law Enforcement undertaken by the IIT Research Institute team sponsored by NASA's Technology Utilization Division

This Problem Statement calls to your attention significant technological needs in an important area of concern in the public sector. We hope to bring to bear on this problem the information and expertise that resides in NASA. If you feel you can contribute, please relate your ideas to the Technology Utilization Officer at your installation, or to the team representative named in the statement.

STATEMENT OF THE PROBLEM

The police need a method to examine various types of paper to detect the presence of indented writing, and to reconstruct and record the information it contains.

BACKGROUND INFORMATION

Indented writing is the image of a written message which has been transferred from the original as an impression in the surface of a succeeding layer of material. Very often loose pieces of paper such as note paper, typing paper or other stationery are used as backing sheets for previously written messages. Of course, this is nearly always true for all except the top sheet of a pad of paper. Each time a piece of paper is used as a backing sheet, a portion of the message is transferred to it from the original in the form of indented writing. The police often encounter this type of evidence, for example, in gambling raids where the original copy of telephone numbers and betting amounts has been destroyed but the information is preserved on succeeding pages of a notebook. Depending upon the backing beneath the second sheet, the quality of the papers, the shape of the writing instument, and the pressure applied by the writer, the indented writing in the second sheet is sometimes visible to the unaided eye. But more often than not, the sample of indented writing is too faint to be legible.

In general, an improved technique is most needed to examine a document which contairs one or more superimposed messages. While detection of the presence of indented writing in these cases may not be difficult, recovery of the information by techniques presently in use is often impossible.

Techniques presently in general use include various schemes of side-lighted shadow-casting, thermo-setting plastics and several photographic approaches such as the use of high contrast film. These methods are unable to resolve indentations below a certain threshold. The "Hollywood Detective" technique of shading with a pencil is virtually never used in actual practice as it is more likely to destroy the information than aid in retrieving it.

CHARACTERISTICS OF INDENTED WRITING

The mechanism of indented writing has not been totally characterized, but it is primarily a displacement of the paper fibers rather than a compression process, such as is the case with watermarks. As with any forming process, the shape of the indentation is dependent on the shape of the writing instrument.

Rough measurements made on ball pen indentations indicate that when the depth of the furrow is of the order of 2 mils (50 microns) the information can be recovered using shadow lighting. At depths less than 0.6 mil (15 microns) the presence of indented writing can be visually detected but usually not read. These are approximate values and are given only to indicate orders of magnitude. It is not known at what minimum depth the indentations can be visually discerned.

POSSIBLE APPROACHES

Techniques employed to analyze surface imperfections might be adaptable to this problem. Some approaches are:

1. Mechanical measurement of depth of grooves.
2. Holography.
3. Optical reflection from surfaces.
4. Thin-film thickness measurement techniques.

The method employed should be adaptable to scanning an entire page of copy. A visual display of the recovered information is most desirable.

LITERATURE SEARCH

A computerized search of the aerospace literature has been initiated. A number of pertinent references have already been identified and are listed below. However, some relevant technology might not be identified by this means and any additional references you suggest would be appreciated.

1. Surface Irregularities Detected by Flare Inspection Instrument (Fiber Optics), NASA Tech Brief 69-10152.

2. Surface Profilometer for Examining Grain-Boundary Grooves, AEC-NASA Tech Brief 69-10345.

FOR FURTHER INFORMATION

If you need more details about this problem, or if you wish to discuss your ideas with a team representative, please contact:

F. R. Hand, Director
NASA Technology Applications Team
IIT Research Institute
10 West 35 Street
Chicago, Illinois 60616

Telephone: (312) 225-9630
Extension 5281

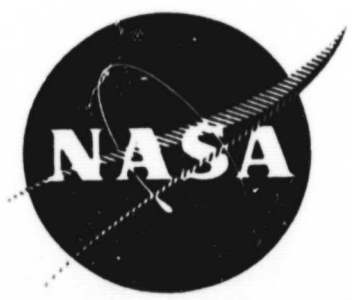
Reference: LE-2

IITRI/LE-3

TECHNOLOGY APPLICATIONS TEAM

VEHICULAR SPEED DETERMINATION

A problem in Law Enforcement undertaken by the IIT Research Institute team sponsored by NASA's Technology Utilization Division



This Problem Statement calls to your attention significant technological needs in an important area of concern in the public sector. We hope to bring to bear on this problem the information and expertise that resides in NASA. If you feel you can contribute, please relate your ideas to the Technology Utilization Officer at your installation, or to the team representative named in the statement.

INTRODUCTION

Existing police vehicle radar systems are limited in their usefulness since they can only be employed at carefully selected, fixed locations. Police traffic control operations could be considerably improved if a speed radar system were available which could also be operated from a moving vehicle.

STATEMENT OF THE PROBLEM

There is a need for a vehicular speed determination system which can be operated from a moving or stationary police vehicle. The system should have the following features.

1. Capability of measuring relative velocities in the range of 5 to 200 mph.
2. Ability to compensate for the speed of the vehicle from which it is operated.
3. Overall system accuracy of $\pm$ 2%.
4. Direct readout (digital or meter) of absolute target speed.

POSSIBLE APPROACHES

Available radar systems are not suitable for operation from a moving vehicle due to their inability to distinguish between several targets in a constantly-changing and unpredictable environment. This difficulty might be overcome by:

1. Narrowing the transmitted beamwidth.
2. Processing the composite return signal so as to be able to examine its individual components.

BACKGROUND INFORMATION

A major function performed by local and State Police agencies is traffic control. In order to enforce speed limits, the police must be capable of accurately and safely determining the speed of moving vehicles.

Speeds were originally determined by clocking the subject vehicle by surveillance and then by the timing of moving vehicles as they traveled a known distance. The development of stationary radar systems has greatly enhanced the capabilities of the police, but they must be carefully sited and can only be operated from a stationary position.

The only commercially available police system for determining the speed of a moving vehicle from another moving vehicle is the VASCAR System. This system is basically a sophisticated stop watch which requires distance judgments by the officers operating it.

Presently available police radar units employ CW Doppler radar, and have a maximum range of 1000-3000 feet with typical antenna beamwidths of between 10 and 15 degrees. At a distance of 1000 feet, a 14 degree beam will cover 240 feet--the equivalent of a multiple-lane expressway. With such wide coverage, there is a high likelihood that an antenna will be illuminating several targets (fixed as well as moving) at any given time. Since the signal detection systems currently employed in police radar receivers respond only to the strongest signal returning from the illuminated field, it would be virtually impossible to select a single vehicle for surveillance when a number of other vehicles and nonmoving objects were within the antenna beam. Were it not for this drawback, existing vehicular radar could readily be adapted for use from a moving vehicle by adding a simple computer which would accept inputs from the radar unit and the patrol car speedometer.

REFERENCES

A literature search of aerospace technology is presently being conducted; however, some relevant references may not be identified by this means, and any additional references you may suggest would be appreciated.

FOR FURTHER INFORMATION

Contact: F. R. Hand, Project Manager
NASA Technology Applications Team
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10 West 35 Street
Chicago, Illinois 60616

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Extension 5281

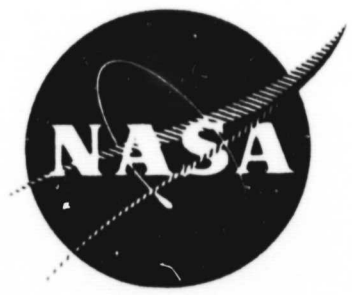
Reference: LE-3

IITRI/LE-4

TECHNOLOGY APPLICATIONS TEAM

AGE AND SEQUENCE OF BALL PEN WRITING ON DOCUMENTS WITH MULTIPLE ENTRIES

A problem in Law Enforcement undertaken by the IIT Research Institute team sponsored by NASA's Technology Utilization Division



This Problem Statement calls to your attention significant technological needs in an important area of concern in the public sector. We hope to bring to bear on this problem the information and expertise that resides in NASA. If you feel you can contribute, please relate your ideas to the Technology Utilization Officer at your installation, or to the team representative named in the statement.

STATEMENT OF THE PROBLEM

In the investigation of documents with multiple writings, the crime laboratory has the need for a nondestructive method to establish a) the age of ball pen writing, and b) the sequence of the different entries or writings.

POSSIBLE APPROACHES

The method can be based on one or more of the following:

1. Difference in diffusivity of inks, depending on age and properties, into suitable absorbant media.

2. Composition of ink, e.g., type of dye, vehicle, size of pigment particles.

3. Examination of ink or metal debris in "furrows" to establish continuity of the most recent writings by microscopy or other methods.

4. Establishment of continuity at line crossings by techniques used in the examination of indented writing.

5. Differentiation of writings on the basis of intensity of color, which depends on the rate of flow of ink. Inkflow rate is determined by speed of ball and writing pressure, both of which may be characteristic of an individual.

BACKGROUND INFORMATION

The age and sequence of each writing in a document containing more than one writing is often of critical importance in criminal investigations. Most documents in this category carry ballpoint pen writings. The special properties of ballpoint pen inks and the percussive nature of ballpoint pen writing, make ink characterization and the determination of the sequence of writing feasible.

Deposition of ink on paper by a ballpoint pen is a complex process. The fabric of the paper consists basically of a mesh of fibers with "gaps" or pores ranging from .5 μ to several μ in diameter and depths of 5 to 100 μ depending on the thickness of the paper. Modern ballpoint pen inks are the quick drying type and consist of synthetic oil soluble dye dispersed in a thixotropic vehicle of a glycol, resin and surfactant. The dye particles which lodge themselves in the fabric of the paper are usually 1 to 3 μ in diameter. The dye itself constitutes about a third of the weight of the ink and has a tinctorial strength of about 20 times that of ordinary fountain pen inks.

Ballpoint pen inks have a viscosity of 25 to 200 poise and will not flow through the 5 μ clearance between ball and socket except at high shear rates created by the ball rotating at speeds of up to 3,500 rpm. The hard stainless steel ball normally abrades the relatively soft bronze or brass socket during writing and the metal debris flows along with the ink onto the paper.

The thickness of ballpoint pen ink films on paper is of the order of .1 to 2 μ and a line one cm long normally contains one μg (i.e., 10^{-6} gram) of the ink.

PRESENT METHODS

At present, there is no standard method for the determination of age and sequence of multiple writings in a document. Differentiation of writings and inks is often achieved by visual or microscopic examinations and by infrared and fluorescence methods. It is believed that ballpoint pen inks are not amenable to such methods because only a handful of manufacturers control their market, and therefore their formulations do not show much variation. However, the complexity of the mechanics of writing with ball pens coupled with the necessarily rapid progress in the development of better ink formulas, should make the

determination of their age in sequential writing only less rather than more difficult. In fact, on the basis of their composition alone, it should be possible to broadly relate ball pen inks to chronological brackets. The maximum age of an ink or writing may then be determined, if its composition is known.

FOR FURTHER INFORMATION

If you need more details about this problem, or if you wish to discuss some of your ideas with a team representative, please contact:

F. R. Hand, Director
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Telephone. (312) 225-9630
Extension 5281

Reference: LE-4

C. Aerospace Literature Searches

To date, literature searches have been initiated on the following problems:

MS-1, Dust Monitoring In Coal Mines
MS-2, Detection for Automatic Quenching of Coal Mine Explosions
MS-3, Measurement of Air Flow Velocities in Coal Mine Passages
MS-4, Quenching of Coal Mine Explosions
MS-5, Mine Rescue Communications
MS-6, Improved Batteries for Underground Coal Mines
LE-3, Vehicular Speed Measurement

The searches for MS-1, MS-4, and MS-5 were initiated during the first quarter. The searches for MS-1 and MS-4 were completed during that period.

During the current quarter, the results were received from the following searches: MS-2, MS-3, MS-5, and MS-6. The computer evaluation reports for each search completed to-date are found on pages 40 through 48.

As an experiment to add some insight on how best to work with the Regional Disseminator Centers, the search for problem LE-3 was submitted to both ARAC and KASC. The problem statement was submitted along with a list of descriptor terms prepared by the team member handling the problem. The strategy was prepared from this list by the RDC staff member. As of 31 December, the strategy used by KASC had been communicated to the team. It is as follows:

A - Radar
B - Continuous Wave Radar
C - Doppler Radar
D - Optical Radar
E - Pulse Doppler Radar
F - Radar Beams
G - Radar Data
H - Radar Equipment
I - Radar measurement
J - Radar Range
K - Radar Resolution
L - Radar Scanning
M - Radar Cross Sections
N - Radar Signatures
O - Radar Tracking
P - Surveillance Radar
Q - Tracking Radar
R - Target Acquisition
S - Target Recognition
T - Moving Target Indicator
U - Range and Range Rate
V - Signatures
W - Surveillance
X - Spectrum Analysis
Y - Velocity Measurement
Z - Speed Indicators

AA - Time Measurement
BB - Motion
CC - Police
DD - Velocity
EE - Vertical Motion

These terms are combined in the following expression:

(A+B+C+D+E+F+G+H+I+J+K+L+M+N+O+P+Q).(R+S+T+U+V+W+X+Y+Z+AA+BB+CC+DD+EE)

The strategy used by ARAC has not yet been received. However, we learned that they plan to use a weighted term strategy. In such a search strategy each term is assigned a numerical weight. The values of all terms for which a document is indexed are summed. If the sum exceeds a pre-determined threshold the document is retrieved.

Members of the team agree that it would be desirous to learn more about the RECON system developed by NASA to perform literature searches in direct communication with the computer. Such a capability would enable real-time evaluation and modification of search strategies by the team member most familiar with the problem under study. We have received approval during this month to use the terminal facility at NASA Lewis Research Center, and are generating an experiment to conduct on that terminal which will provide us with a good understanding of the system operation.

Mr. Jay Arnold, who has had previous experience with RECON and Mr. John Weyer will perform this experiment early in January. They will attempt to conduct search on 5 - 6 problems using different conditions on each. For example, they will perform a search for problem LE-3 using, as a base, terms suggested to both ARAC and KASC. Searches for problems MS-8 and LE-2 will use a telephone link to IITRI and the team member responsible for the problem. One problem will be searched from just two or three beginning terms, with the strategy being expanded by interaction with the RECON system.

COMPUTER EVALUATION REPORT

RDC: ARAC

Search Title: Quick Response Quenching of Explosions

Problem Statement: Quenching of Coal Mine Explosions; MS-4

Date Search Initiated: 25 August 1969

Search Terms:

SAL Terms

A - Sprayer
B - Relief Valve
C - Fuel Valve
D - Spraying Apparatus
E - Fuel Spray
F - Fire Extinguisher
G - Propellant Actuated Device
H - Liquid Injection
I - Extinguisher
J - Liquid Cooling
K - Fuel Injection
L - Fluid Injection
M - Quenching
N - Valve

SAL Strategy:
(B+F)+(A+C+D+E+G+I+N).(H+J+K+L+M)

THESAURUS Terms

A - Propellant Actuated Devices
B - Fuel Sprays
C - Relief Valves
D - Fuel Valves
E - Sprayers
F - Extinguishing
G - Liquid Injection
H - Fire Extinguishers
I - Quenching
J - Liquid Cooling
K - Valves
L - Fluid Injection
M - Quenching (Cooling)

THESAURUS Strategy:
(C+H)+(A+B+D+E+K).(F+G+I+J+L+M)

Date Search Received: 1 September 1969

Number of Hits: 24

Results: 49 abstracts
24 related to problem
8 Tech Briefs and other documents

COMPUTER EVALUATION REPORT

RDC: ARAC

Search Title: Environmental Dust in Coal Mines - A4036

Problem Statement: Dust Monitoring in Coal Mines; MS-1

Date Search Initiated: 18 September 1969

Search Terms:

SAL Terms

A - Air Purification
B - Microparticle
C - Air Pollution
D - Micrometeoroid
E - Smoke
F - Micrometeorite
G - Environmental Control
H - Density Measurement
I - Aerosol
J - Dust
K - Measuring Apparatus
L - Transducer
M - Detection
N - Detector

SAL Strategy:
(A+G+H+K+L+M+N).(B+C+D+E+F+I+J)

THESAURUS Terms

A - Electrostatic Precipitators
B - Dust Collectors
C - Air Purification
D - Microparticles
E - Detectors
F - Smoke
G - Clean Rooms
H - Electrostatic Charge
I - Density (Number/Volume)
J - Size Determination
K - Gravimetry
L - Micrometeoroids
M - Dust
N - Detection
O - Environmental Control
P - Transducers
Q - Density (Mass/Volume)
R - Air Pollution
S - Density Measurement
T - Optical Measuring Instruments
U - Aerosols
V - Particle Size Distribution
W - Measuring Instruments

THESAURUS Strategy:
(A+C+E+G+I+J+K+N+O+P+Q+S+T+W).(D+F+H+L+M+R+U+V)+(B)

Date Search Received: 30 September 1969

Number of Hits: 113

Date Documents Requested by Researcher: 20 October 1969

Number of Documents Requested and Document Numbers:
Six Microfiche reproductions: N66-29075
N68-29340
N66-25166
A67-11037
A68-31553
N67-40516 - N69-40525

Researcher Evaluation of Search: The 6 references listed above and 5 others obtained from IITRI sources formed the primary and secondary sources of the required information.

Plans for Use of Information: On the basis of search contacts with one NASA Installation has been made and the information has potential for technology transfer.

COMPUTER EVALUATION REPORT

RDC: KASC

Search Title: Mechanical Communication Between Persons Trapped Inside of a Mine and Rescuers on the Surface.

Problem Statement: Mine Rescue Communications; MS-5

Date Search Initiated: 18 September 1969

Search Terms:

A - Seismic Waves
B - Infrasonic Frequencies
C - Sound Transmission
D - Very Low Frequencies
E - Sound Transducers
F - Electroacoustic Transducers
G - Acoustic Excitation
H - Sound Generators
I - Acoustic Propagation
J - Sound Propagation
K - Acoustic Attenuation
L - Signal Detection
M - Correlation Detection
N - Sound Localization
O - Earth Crust
P - Rocks
Q - Soils
R - Mines
S - Excavations

Strategy:
(A+B+C+D+E+F+G+H+I+J).(K+L+M+N+O+P+Q+R+S)

Date Search Received: 10 October 1969

Number of Hits: 38

Results: 141 citations
38 relevant
14 actually useful to problem

COMPUTER EVALUATION REPORT

RDC: KASC

Search Title: Electrical-Magnetic Communication Between Persons Trapped Inside a Mine and Rescuers on the Surface

Problem Statement: Mine Rescue Communications; MS-5

Date Search Initiated: 18 September 1969

Search Terms:

A - Communication Equipment
B - Broadcasting
C - Telephony
D - Radio Communication
E - Wireless Communication
F - Telecommunication
G - Radio Transmission
H - H-waves
I - Signal Transmission
J - Radio Receivers
K - Transmitters
L - Radio Relay Systems
M - Radio Direction Finders
N - Long Wave Radiation
O - Radio Waves
P - Low Frequencies
Q - Electromagnetic Wave
R - Radio Attenuation
S - Electromagnetic Absorber
T - Radio Reception
U - Radio Tracking
V - Integrated Circuits
W - Microelectronics
X - Miniaturization
Y - Miniature Electronics
Z - Triangulation
AA - Very Low Frequencies
BB - Antennas
CC - Earth Crust
DD - Rocks
EE - Soils
FF - Magnetic Signals
GG - Carrier Waves

Strategy:

(A+B+C+D+E+F+G+H+I+J+K+L+M).(N+O+P+Q+R+S+T+U+V+W+X+Y+Z+AA+BB+CC+DD+EE+FF+GG)

Date Search Received: 10 October 1969

Number of Hits: 105

Results: 1200 Citations
105 relevant
38 Useful to Problem

COMPUTER EVALUATION REPORT

RDC: KASC

Search Title: Storage of Primary Batteries for Power Operated Equipment

Problem Statement: Improved Batteries for Underground Coal Mines; MS-6

Date Search Initiated: 30 October 1969

Search Terms: Tentative list; actual list and strategy not yet received.

A - Electric Batteries
B - Primary Batteries
C - Storage Batteries
D - Electrolytic Cells
E - Wet Cells
F - Electric Cells
G - Drills
H - Boring Machines
I - Tools
J - Conveyers
K - Pumps
L - Materials Handling

Date Search Received: 25 November 1969

Number of Hits: 87

Results: 234 Citations
87 Checked relevant
2 Tech Briefs

COMPUTER EVALUATION REPORT

RDC: ARAC

Search Title: Characteristics of Coal Mine Explosions

Problem Statement: Detection for Automatic Quenching of Coal Mine Explosions; MS-2

Date Search Initiated: 30 October 1969

Search Terms:

A - Detection
B - Detectors
C - Warning Systems
D - Warning
E - Safety
F - Explosions
G - Flash
H - Flames
I - Blasts
J - Detonation
K - Fires
L - Dust
M - Gases
N - Methane
O - Coal
P - Combustion
Q - Supersonic Combustion
R - Underground Explosions
S - Deflagration
T - Ignition
U - Detonable Mixtures
V - Flammable Gases
W - Powder (Particles)
X - Gas Mixtures
Y - Hydrocarbon Fuels
Z - Bitumens
AA - Hydrocarbon Combustion
BB - Gas Explosions

Strategy not yet received.

Date Search Received: December 8, 1969

Results: 34 Abstract citations
7 Tech Briefs - 1 paper
6 relevant (1 Tech Brief)

COMPUTER EVALUATION REPORT

RDC: ARAC

Title Search and RDC Number: Air Flow Measurement, A4075

Problem Statement: Measurement of Air Flow Velocities in Coal Mine Passages, MS-3

Date Search Initiated: 13 November 1969

Search Terms:

SAL Terms

A - Wind Vane
B - Anemometry
C - Exhaust System
D - Mine
E - Hot-Wire Measurement
F - Low Velocity
G - Mining
H - Hot-Wire Anemometer
I - Flow Meter
J - Tunneling
K - Anemometer
L - Low Speed
Z - Measuring Apparatus

M - Air Duct
N - Ventilator
O - Air Conditioning
P - Air Current
Q - Wind Velocity Measurement
R - Vent
S - Wind Velocity
T - Flow Measurement
U - Wind Measurement
V - Velocity Measurement
W - Flow Velocity
X - Air Flow
Y - Ventilation

SAL Strategy:

(A+B+C+D+E+F+G+H+I+J+K+L+Z).(M+N+O+P+Q+R+S+T+U+V+W+X+Y)

THESAURUS Terms

A - Passageways
B - Tunnels
C - Tunneling (excavation)
D - Wind Vanes
E - Tunneling
F - Chimneys
G - Mines (Excavations)
H - Speed Indicators
I - Exhaust Systems
J - Hot-Wire Flowmeters
K - Low Speed
L - Anemometers
M - Indicating Instruments
N - Flowmeters

O - Hot-Wire Anemometers
P - Ventilators
Q - Vents
R - Air Conditioning
S - Venting
T - Air Ducts
U - Air Currents
V - Ventilation
W - Wind Velocity Measurement
X - Wind Measurement
Y - Flow Measurement
Z - Air Flow
AA - Wind Velocity
AB - Velocity Measurement

THESAURUS Strategy

(A+B+C+D+E+F+G+H+I+J+K+L+M+N+O).(P+Q+R+S+T+U+V+W+X+Y+Z+AA+AB)

Date Search Received: 24 November 1969

Number of Hits: 128

Results: 15 references considered immediately pertinent

D. Technology Identified and Transfer Potential

During the first quarter, in searching for technology relating to the measurement of dust (MS-1) a very attractive instrument was located at NASA Electronics Research Center at Cambridge, Massachusetts. The details of this technology were reported in the first quarterly report. It is compact, self-powered, easily portable, and has digital, real-time read out of particle counts in five size ranges from 0.5μ to 10μ. This instrument is based on the scattering of light by the dust particles, each particle generating a light pulse at the detector, which is then counted to obtain the number of particles.

The instrument at ERC is undergoing further development to incorporate laser optics into its system. There is already a working model in the laboratory. Using solid state laser devises may result in an instrument that is less expensive and even more compact.

There are some problems associated with light scattering as applied to measuring dust in a coal mine. For example, the instrument is not able to determine the mass of the particle being counted, and therefore is not able to provide directly a gravimetric measurement as desired by the mining industry. An average density can be used as a conversion factor for a particular mix of types of dust, but this can only be approximate at any given time. Also, the instrument is not able to give separate measurements of rock dust and coal dust concentrations - at least in its present form. There might be modifications - such as spectrally analysing the scattered light - which would give this information but they are not presently under development.

The ERC development is considered to be so significant, however, and close to the needs of the mining situation, that a report is being prepared to transmit this information to the Bureau of Mines. It will also include some of the unique features of an instrument developed for Marshall Space Flight

Center. This latter is not a portable instrument and does not represent a direct transfer, but contain some technical developments which might be incorporated in a portable unit. One of these is a sheath of laminar-flow air which surrounds the measurement sample and protects the optics from contamination by the dust.

The report will indicate how the instrument can be applied to dust monitoring in a mine, what further engineering is required to adapt the instrument to the Bureau's requirements, and an estimate of the instrument's probable cost. The report will be submitted to Dr. Van Dolah at the Pittsburgh laboratories of the Bureau, who originated the problem with the team.

Verbal communication to Dr. Welby Courtney, of the Bureau of Mines in Pittsburgh has by Dr. Singh of the IITRI team raised many of the questions discussed above. If these questions and that of the instrument's capacity can be answered satisfactorily, we believe the Bureau of Mines will find the ERC development a most useful instrument. Prospects for a meaningful transfer continue to be encouraging.

In doing some initial searching of NASA Tech briefs for Problem LE-2, Detection and Recovery of Indented Writing, two items of technology have been located which may have promise for use in an instrument which would visually display the written information. The instrument would scan the questioned document in an x-y grid. An electrical (or mechanical) output would be recorded each time a sensor crossed an indentation. An x-y recorder would be driven in synchronism with the scanning mechanism. The output from the instrument would drive the recording pen to place a mark on the graph each time a groove is crossed. In this way the instrument would reproduce the image on the questioned document such that it could be read directly.

An instrument has been developed for Marshall Space Flight Center by Electro-Physics, Inc. which was designed to scan the surface of flares, looking for imperfections. The instrument uses a fiber optic probe which is capable of measuring cracks and surface features up to several thousandths of an inch to an accuracy of a few microinches. This is just the range of depths encountered in the indented writing problem. This technology was reported in NASA Tech brief 69-10152.

Another development which might have application to the same type was reported by Argonne National Laboratory in NASA-AEC Tech Brief 69-10345. This item uses a diamond stylus of one micron radius to traverse the surface in question. Magnifications up to 100,000 X are possible and the output is displayed on an x-y recorder. The Argonne instrument was designed for a total traverse of 0.5 inch but this could be modified for the particular application.

These two items were reported to Miss Maureen Casey, head of the Documents Section of the Chicago Police Crime Laboratory, to discuss the kind of system which would likely evolve from such technology and the cost-effectiveness of such a system.

Miss Casey pointed out that in order to justify purchase of an expensive instrument for the detection of indented writing, an estimate of the total man-hours saved on solving indented writing problems would have to be made. Such problems presently account for less than 20% of the load at the Chicago Police Department. It is difficult, at this point, to estimate the transfer potential of these items of technology, but they do appear to be useful techniques.

In the search conducted at ARAC on the problem of air flow measurement, MS-3, 128 abstracts and 11 Tech Briefs were received, of which 16 abstracts were considered to be especially relevant. A survey of this material so far indicates that the only reported feasible device for measurement of very low air velocities is the so called Laser Doppler Velocimeter (LDV). Development of such

a device has been funded by several federal agencies including NASA. Only one instrument is currently on the market - one which measures particle movement in liquids.

The LDV utilizes the principle of the Doppler shift in frequency of light scattered by particles moving in an air stream. In a coal mine, there is no need to introduce particles to the air flow - the coal and rock dust are already present in sufficiently high concentration. LDV instruments are currently very elaborate and expensive. The team will pursue this avenue of approach to determine if such a system can be made cost-effective for coal mine applications. If the cost proves to be high, however, the transfer potential of Laser Doppler methods to coal mining is not great.

The literature searches for other problems, such as Mine Rescue Communication, Explosion Detection and Quenching, and Batteries have turned up little in the way of significant new technology. In the Communications problem, for instance, experiments have shown that very low frequency electro-magnetic fields are the only media which has sufficient penetration depth in earth to reach the depths encountered in mines. Yet NASA and other aerospace agencies have little interest in VLF communication. The literature search located some propagation data, but no significant technology. In the case of the battery problem, it appears that most technological break throughs are achieved by the battery manufacturers and ultimately find their way into the commercial market. Our search turned up no significant new technology.

IV. SUMMARY

IV. Summary

This report has presented the activities of the IITRI Technology Applications Team for the months of October, November, and December. During this time the team has identified a number of problems in Law Enforcement and Mine Safety, and has obtained sufficient background data, and performed an analysis of each problem in order to write Problem Statements which are circulated to NASA scientists and engineers. For each problem, a search of the aerospace data bank was performed in order to locate relevant items of technology contained in some 700,000 aerospace reports.

During this quarter, a great deal was learned about the techniques for performing the literature searches. In looking for the optimum way of working with the Regional Dissemination Centers, the team found that the problem should be submitted to RDC along with a strategy suggested by the team member based on his understanding of the problem. The strategy can then be modified by the RDC staff member who has greater familiarity with the indexing system.

Items of technology with a reasonably high potential for transfer were located for application to dust monitoring in coal mines and detection of indented writing. A report is being prepared for the former, to transmit the information about the technology to the problem originator at the Bureau of Mines. In the case of the latter, inquiry of the developers of the technology will help determine the feasibility and the cost-effectiveness of the techniques. This will be done in the next reporting period.

The team has now, with the help of NASA representives from the Office of Technology Utilization, established the relationships with agencies in Law Enforcement and Mine Safety which will be necessary to effect meaningful technology transfers. We expect that the next quarter will see an increase in actual transfer activity, with the identification of new problems, responses from NASA field centers beginning to increase, and search strategies beginning to pay off in new technology.