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Continuous Speech Recognition as an Input
Method for Tactical Command Entry
in the SH-60B Helicopter

by

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The experiment was successful and demonstrated that continuous speech recognition is an effective means of reducing the Airborne Tactical Officer's taskload. This thesis discusses the research methodology, reviews and analyzes the data collected, and draws conclusions about the feasibility of incorporating a continuous speech recognition system for command entry in the SH-60B helicopter.

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Continuous Speech Recognition as an Input Method for Tactical Command Entry in the SH-60B Helicopter

by

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ABSTRACT

An experiment was conducted to determine whether a continuous speech recognition system would reduce the SH-60B Airborne Tactical Officer's taskload. The experiment made use of a Verbex Series 5000 speech recognizer. Ten subjects entered 45 commands frequently used by the Airborne Tactical Officer via two input methods: continuous voice and keying.

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TABLE OF CONTENTS

I. INTRODUCTION

A research experiment was conducted to determine whether a continuous speech recognition system would reduce the SH-60B Airborne Tactical Officer's taskload. The experiment used a Verbex Series 5000 speech recognizer. Ten subjects entered 45 commands frequently used by the Airborne Tactical Officer via two input methods: continuous voice and keying. Statistics were compiled, for both input methods, which measured the subjects' performance based on time and accuracy of command entry. This thesis discusses the research methodology, reviews and analyzes the data collected, and draws conclusions about the feasibility of incorporating a continuous speech recognition system for command entry in the SH-60B helicopter.

A. BACKGROUND

1. The Aircraft and its Mission

The SH-60B Seahawk, manufactured by the United Technologies Corporation, Sikorsky Aircraft Division, was introduced to the operational U.S. Navy in 1984. It is a twin-engine, medium weight helicopter, configured with a single main rotor. (NATOPS Flight Manual,1987,p.I-1-1)

The helicopter was designed to meet the requirements of the Navy's LAMPS program. LAMPS is an acronym for Light Airborne Multipurpose System. As an integral component of

LAMPS, the SH-60B extends the search and attack capabilities of LAMPS configured surface ships against hostile submarines and missile-equipped surface combatants.

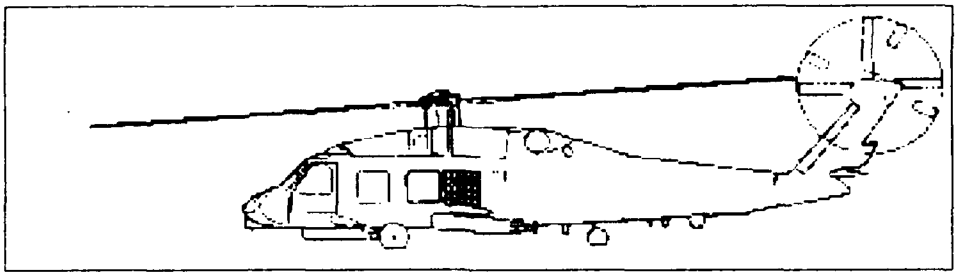

Figure 1 SH-60B Helicopter

The primary mission of the SH-60B is Antisubmarine Warfare (ASW). In this role, the SH-60B launches from its parent ship upon detection of a submarine threat. The SH-60B proceeds to the threat area and drops sonobuoys (underwater listening devices) to localize the target. Once localized, the SH-60B will attack the target with one or both torpedoes.

The secondary mission of the SH-60B is Antiship Surveillance and Targeting (ASST). Here the aircraft provides a mobile, elevated platform for observing, identifying, and localizing surface, subsurface, and air threats to the parent ship.

Tertiary missions include vertical replenishment - moving material between ships, search and rescue, medical evacuation of patients from ships, communication relay - where the aircraft provides for over the horizon communications between distant units, and forward air spotting for surface ships' gunfire. (LAMPS Weapon System Manual,1990,p.1-1)

2. Crew Configuration and Responsibilities

The aircraft is manned by a crew of three: pilot, Airborne Tactical Officer (ATO), and Sensor Operator (SO). The pilot and ATO sit in the forward right and left crewstations, and the SO's station is in the cabin, aft of the pilot and ATO. The ATO's primary responsibility is to assist the pilot in the safe execution of the flight. In that role he is the copilot of the aircraft. The ATO must be concerned with aircraft altitude, attitude, engine and flight system performance, etc. More than just "an extra set of eyes and ears in the cockpit," the copilot must be able to take the controls of the aircraft at any time to avoid an unsafe flight condition.

In addition to being the safety net for the pilot, the ATO must conduct the tactical aspects of the mission. The ATO, working closely with the SO, receives information from many sources to help him make tactical decisions such as where to drop sonobuoys, the type of search plan to follow, the optimal approach path to fly for target identification, and target characteristics. Information the ATO needs to make tactical decisions is obtained onboard the SH-60B from two AN/AYK-14 computers, commonly referred to as SAC 1 and SAC 2. (LAMPS Weapon System Manual,1990,p.2-40)

3. ATO - Computer Interface

The ATO interfaces with the SH-60B's onboard computers via a 75-key keyset (see Appendix A) and a multipurpose display, simply a monitor. The ATO keyset is mounted on the center console of the cockpit, which separates the pilot's and copilot's seats. The keyset is positioned longitudinally on the console, running approximately from the copilot's knee to hip. The multipurpose display (MPD) is located on the instrument panel, raised above and forward of the keyset (see Figure 2).

Individual keys on the keyset represent different functions that allow the ATO to conduct a mission. There are over forty distinct functions that the ATO can perform through the keyset. For example, the ATO can create fly-to points, create symbols to represent a sonobuoy's position, and create tracks to represent air, surface, and subsurface contacts.

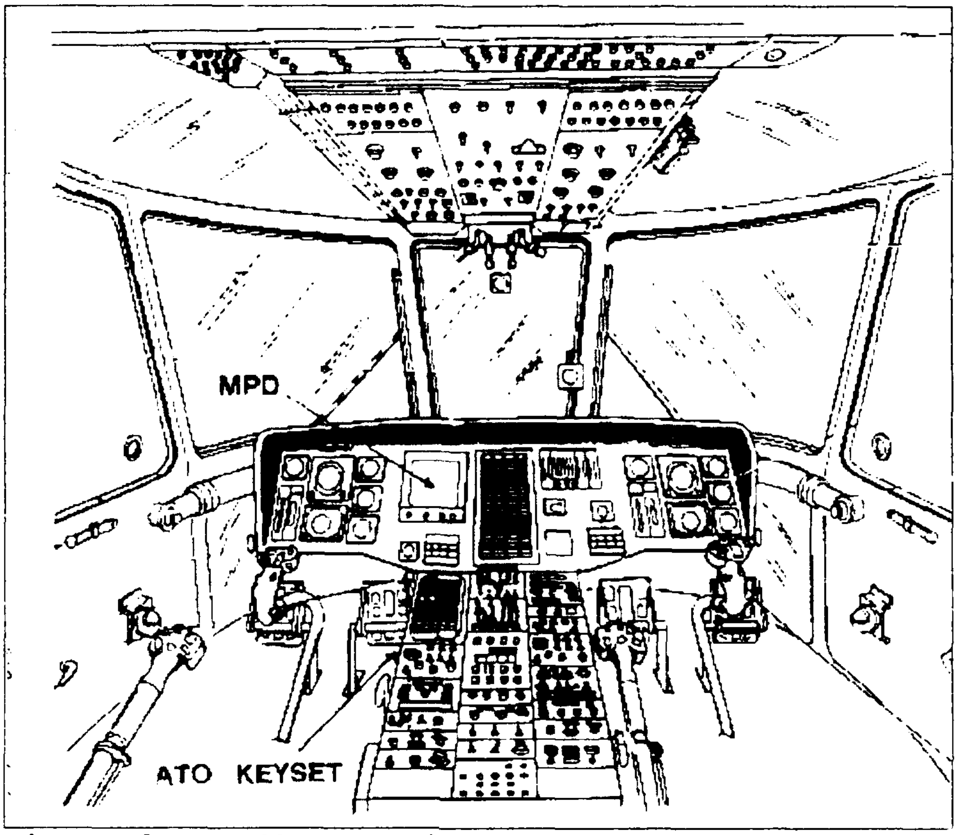

Figure 2 SH-60B Cockpit

B. PROBLEM

The ATO's duties are defined by two highly dissimilar tasks: assisting the pilot to fly safely, and performing the tasks of a mission specialist. While performing a mission, the ATO interfaces with the onboard computers, which is a distraction from his copilot duties. Specifically, the ATO is unable to scan the flight instruments on the instrument panel while entering commands via the keyset. During a mission, the ATO spends a large percentage of his time keying commands into the computers. This involves glancing down to the center console, locating the desired key on the keyset, pressing the key, then looking up to the MPD on the instrument panel to ensure that the correct key was pressed. In addition, many tactical system functions require that the ATO navigate through embedded menus which forces the ATO to look from the keyset to the MPD to the keyset, and so on. For example, if the ATO wants to enter a hostile surface track, he must navigate through four submenus, each requiring the ATO to glance up to the MPD to confirm his previous menu choice and select a new one.

Entering commands into the SH-60B's computers is a time-consuming, repetitious process that requires the full attention of the ATO. Many simple commands require a large number of keystrokes. For example, 11 keystrokes are needed to create a sonobuoy fly-to point, 5 of which use the key "ENTER NO CHNG."

The process of entering commands into the SH-60B's tactical computers detracts from the ATO's primary role as a safety observer for the pilot. While searching for a key on the keyset, he is not scanning the instruments and would be unable to take immediate control of the helicopter in an emergency. Command entry also tends to keep the ATO's focus inside the cockpit - not searching outside for nearby air traffic. In extreme cases, command entry could presumably cause the ATO to experience vertigo or spatial disorientation, especially at night or during flights when no horizon is visible. An attractive alternative to command entry via keyset is continuous speech recognition.

C. SPEECH RECOGNITION

Speech recognition systems enable the user to interface with a computer via speech rather than a keyset. Speech recognition systems can be traced back to the 1950's and 1960's and have quickly become an effective means for data entry - especially in a hands-off environment.

Speech recognition systems can be classified into four categories: speaker dependent, speaker independent, discrete, and continuous. Speaker dependent systems require samples of the user's voice to be in memory in order to function properly. Therefore, a speaker dependent system is fine-tuned for a particular user, making it ideal for applications where the same user performs the same tasks day after day. (Poock,1986,p.1278)

A speaker independent system makes use of what amounts to a generic voice sample that can be used by many people. Since it does not contain samples of an individual user's voice, theoretically it cannot be expected to perform as well as a speaker dependent system.

A discrete, or isolated, speech system requires that each utterance, or word, be followed by a pause of about .10 seconds. Once the system detects a pause, it "knows" that an utterance was spoken and it searches its memory to match what was said. After it finds a match, it listens for the next utterance.

Continuous speech systems require no pause between utterances. The system must decide where a word begins and ends, in addition to matching what it "heard" to the words in its memory. For example, when the phrase "hostile surface 180010" is spoken, the recognizer must be able to discern when the "1" sound ends and the "8" sound begins. (Poock,1986,p.1279)

Continuous speech recognition systems afford the user two distinct advantages over discrete systems: continuous speech is a natural mode of human communication, and continuous speech is spoken quicker than discrete speech. (Lee,1989,p.7)

D. SCOPE

This thesis examines the feasibility of incorporating a continuous speech recognition system to allow the ATO to input voice commands into the SH-60B's onboard computers. In addition, it explores whether the use of a continuous speech recognition system can enhance the effectiveness of an ATO as both a mission specialist and copilot by measuring the time and accuracy of command entry via continuous speech versus manual keying.

E. LIMITATIONS

Time limitations precluded the introduction of an intervening task, such as reading a gauge, to measure the effects that the method of command entry (continuous voice or keying) has on the subject's scan. Time limitations also precluded identifying the actual hardware and software changes and connections that would need to be made to the SH-60B to accommodate a speech recognizer. The results herein are system specific and cannot be generalized for all dependent, continuous speech recognition systems.

II. EXPERIMENTAL PROCEDURE

A. SUBJECTS

Ten subjects (all male) were recruited from the Naval Postgraduate School in Monterey, California. All were military personnel from either the Navy, Army, or Marines. Three of the subjects had experience as ATO's in the SH-60B. Although some subjects had educational knowledge of speech recognition systems, the majority had no actual experience using a speech recognition system before this experiment.

B. SPEECH RECOGNITION SYSTEM

1. Hardware

An off-the-shelf speech recognition system manufactured by Verbex Voice Systems, Inc., the Verbex Series 5000 Conversational Input/Output System was chosen for this experiment. The Verbex Series 5000 is a computer peripheral that allows users to send data to computers by voice. (Grammar Development Manual,1990,p.1-2)

The Verbex Series 5000 can operate in a stand-alone mode; however, for this experiment, the Verbex Series 5000 was connected to a Unisys personal computer (the host computer) to facilitate the transfer of files into and out of the recognizer. If used in the stand-alone mode, the recognizer can function as a host computer, but each subject would require a separate cartridge to hold their own files - an unattainable condition due to limited resources.

A headset incorporating a noise-canceling boom mike was used to input voice commands to the speech recognizer.

2. Software

Verbex Version 3.00 software allows the recognizer to understand and translate spoken language into digital information. (Project Administrator's Manual,1990,p.1) In order to accomplish this, the recognizer must be given two files: a recognizer file and a voice file.

> The recognizer file contains a list of words the user is going to say during the application (a vocabulary)...rules about the orders and patterns in which these words may be spoken (a grammar)...and a table of computer codes for each word (a translation table)...
> The voice file contains a library of sound patterns for all the words in the recognizer file, both as they sound when spoken individually...and spoken together...in the patterns set forth in the grammar in the recognizer file. (Project Administrator's Manual,1990,pp.1-2)

Therefore, the following steps are required to create and use an application with the Verbex Series 5000:

1. A grammar file is created with a text editor that defines the vocabulary and grammar patterns that the recognizer will accept.

2. The grammar file is converted by software in the host computer into a recognizer file which is readable by the recognizer.

3. The recognizer file is transferred to the recognizer's internal memory by the host computer.

4. Each user trains the recognizer to the sound of his/her voice. During the training process a voice file is created.

5. Recognition takes place when the recognizer matches a spoken phrase to the template of phrases in the voice file <u>and</u> the spoken phrase fits the grammar defined in the recognizer file.

6. User-defined code is output from the recognizer to the host computer in response to a recognized phrase. This feature allows the user to confirm the successful recognition of a phrase. (Project Administrator's Manual,1990,p.5)

C. ATO GRAMMAR FILE

The goal in writing a grammar file was to translate all of the commands available to the ATO into logical voice commands. The most intuitive way to structure the voice commands was to use a form of shorthand that is familiar to the ATO. For instance, using the keyset, the following 15 keys are pressed to create a friendly surface track whose course is 256 degrees and speed is 21 knots:

1. HOOK VERIFY
2. NEW TRACK
3. 1 (to select HOOK)
4. ENTER NO CHNG
5. 2 (to select VISUAL)
6. ENTER NO CHNG
7. 4 (to select FRIENDLY SURFACE)
8. ENTER NO CHNG
9. 256021 (six separate keys)

10. ENTER NO CHNG

Using voice commands, the same input is translated to:

1. HOOK NEW TRACK
2. HOOK VISUAL YES
3. FRIENDLY SURFACE 256021 ENTER

The voice commands are shorter and more intuitive to the ATO because there is less reliance on selecting options from menus.

A grammar file containing all the ATO functions was written (Appendix B). With over fifty separate commands, each comprised of one to four phrases, the original grammar file was divided into six separate grammars to reduce the overall complexity of the vocabulary. Despite further attempts to reduce the complexity of the grammar file, a recognizer file was not created. Upon inquiry, a Verbex technical representative offered that Version 3.00 software was occasionally unable to convert files that made use of multiple grammars into a usable recognizer file. (Fergeson,1991)

A grammar file that contains thirteen of the most frequently used commands was written and converted into a recognizer file for this experiment (Appendix C). For a discussion on how to write a grammar file for the Verbex Series 5000 refer to Appendix D.

D. ATO KEYSET

An off-the-shelf 80-key membrane keyset was masked and individual keys were labelled to match the ATO's keyset. The membrane keyset was wired to an XT keyboard controller so that individual keys could be differentiated by separate control characters.

E. EXPERIMENTAL DESIGN

Four sessions were required of each subject. Each of the subjects spent two separate sessions training the speech recognizer. During the first training session, the subject was instructed on how to train the system, and a voice file was created. The second training session "fine-tuned" the voice file that was created earlier.

Two trials were conducted on separate occasions. The procedures for each trial were identical. Each trial required that the subject first speak, then key, a series of commands. The phrases that defined the spoken command were equivalent to the key presses that defined the key-entered command (refer to the ATO Grammar File section above). Time and accuracy statistics were kept for each input mode: voice and key.

Text on a computer monitor gave the subject immediate feedback to reflect what was spoken or keyed.

The experiment was conducted in a laboratory setting at the Naval Postgraduate School, Monterey, California.

F. PROCEDURE

1. Recognizer Training

Before the subjects were able to input voice commands, they first trained the recognizer to their own voice. The training process involved three steps: enrollment, followed by two script training passes. (Project Administrator's Manual,1990,pp. 26-27)

During enrollment, each of the 50 unique words in the vocabulary was spoken by itself. Once these sound patterns were established, the recognizer combined the words to form 426 script phrases. The first script training pass enabled the recognizer to begin to learn how each subject pronounced the words when they were combined. The actual training script was designed by the recognizer to insure that all words in the vocabulary were included in enough phrases to adequately train each word in various combinations. (Project Administrator's Manual,1990,p.27) Once the first script training was complete, a voice file specific to each subject was created. Enrollment and the first training pass took approximately 60 minutes.

A second script training (identical to the first) was conducted about a week later. Most of the subjects were now more familiar with the speech recognizer and tended to speak more naturally. Therefore, the second training pass allowed each subject to further "personalize" their own voice file. That training pass took approximately 45 minutes.

2. Testing

The test procedure was divided into two tasks: command entry via continuous speech recognition and command entry via keying.

The first task required that the subjects enter a total of 45 voice commands using the Verbex Series 5000 speech recognizer. The commands were printed on 15 separate cards. Each card contained 3 commands which varied in length from 1 to 3 phrases. Statistics were kept on the time it took the subject to complete each card and the accuracy of the speech recognizer to recognize the phrases on each card. For this experiment, a misrecognized phrase and an unrecognized phrase were both classified simply as errors.

The second task required that the subjects key, via the replicated ATO keyset, the same 45 commands, which were also printed on 15 separate cards. The keyset was positioned alongside the subject's seat to simulate the cockpit layout of the SH-60B. Again, statistics were kept on the time it took the subject to complete each card, and the number of keys pressed in error.

The Voice Cards and Key Cards are reproduced in Appendix E.

Two identical trials were performed, each approximately one week apart. A trial took approximately 45 minutes.

G. INDEPENDENT AND DEPENDENT VARIABLES

The independent variables were subject (1-10), card (1-15), trial (1-2), and input type (1-2). The two dependent variables were time and accuracy.

III. RESULTS

A. OVERVIEW

An analysis of variance test was performed on both accuracy and time. To permit a more detailed analysis of accuracy, arc sin transformation was applied so that the random variables had a constant variance.(Brownlee, p.144) However, the recognition accuracy figures that appear in Figures 7 and 8 are expressed as percentages and are untransformed.

In this experiment, the null hypothesis states that the method of command input, voice or key, is equivalent.

1 Analysis of Variance for Time

Table I depicts the 4-way analysis of variance for time, where S=Subject, C=Card, TR=Trial, and I=Input Type. All four variables had a significant effect on the results, as the F-ratios clearly show. In addition, significant interdependencies between variables resulted.

TABLE I

ANALYSIS OF VARIANCE ON TIME SUMMARY TABLE

Source	df	SS	MS	F-ratio	Prob
S	9	2271.192	252.355	49.617	<0.001
C	14	6216.920	444.066	87.310	<0.001
TR	1	1117.935	1117.935	219.803	<0.001
I	1	52907.392	52907.392	10402.377	<0.001
S,C	126	1002.106	7.953	1.564	<0.001
S,TR	9	106.247	11.805	2.321	0.019
S,I	9	2593.601	288.178	56.660	<0.001
C,TR	14	193.839	13.846	2.722	0.002
C,I	14	1873.492	133.821	26.311	<0.001
TR,I	1	351.380	351.380	69.086	<0.001
S,C,TR	126	646.446	5.131	1.009	0.481
S,C,I	126	1035.322	8.217	1.616	0.004
S,TR,I	9	361.340	40.149	7.894	<0.001
C,TR,I	14	241.089	17.221	3.386	<0.001
Error	126	640.847	5.086		
Total	599	71559.147	119.464		

2. Impact of Variables on Time

a. 'Subject' Variable

Some subjects had an interactive effect with the other variables. This meant that some subjects performed better on certain cards, trials, and input types, and other subjects vice versa. As in most experiments, one would expect subjects to perform differently and this experiment was no exception; however their variance is isolated in this model.

b. 'Card' Variable

The variable 'card' also had an interactive effect with the other variables. Each of the 15 cards varied in content ie., no two cards were alike. This design enabled a greater number of different commands to be tested. Therefore, 'card' cannot be included as a significant variable because they were all different, and one would expect the times to be different for different cards.

c. 'Input Type' Variable

The 'input type' variable had individual as well as interactive effects on the time results. Figure 3 shows the average time in minutes all subjects spent speaking the commands versus the average time all subjects spent keying the commands. On average, voice input was almost 47 minutes quicker.

Figure 4 further isolates the 'input type' variable. In both trials, the total time it took all subjects

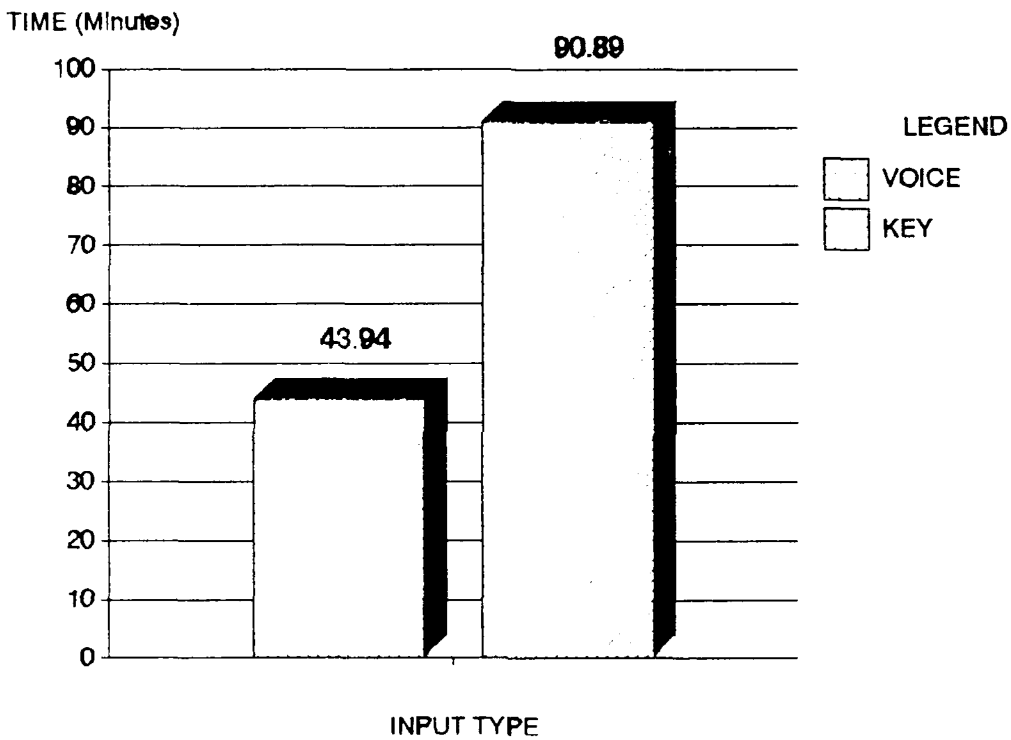

Figure 3 Average Effect of Input Type on Time

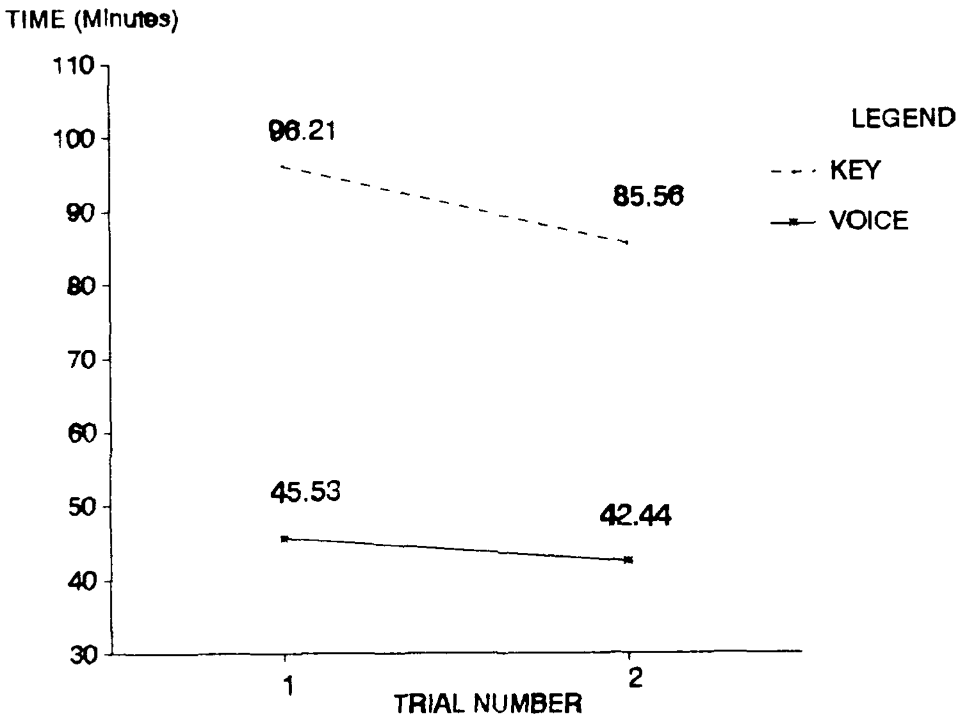

Figure 4 Effect of Input Type and Trial Number on Time

to enter commands using speech recognition was over twice as fast as the time expended to key the commands.

Figures 5 and 6 reveal the time results of card, input type and trial number. In both trials, voice input was consistently quicker than key input for every card. The time shown is the total for all subjects by card.

d. 'Trial' Variable

Taken independently, 'trial' is a meaningless variable. It is illogical to combine both voice and key statistics to define a trial. Therefore, only the interdependencies of 'trial' and the other variables are considered for study. The significant interdependencies involving 'trial' are mentioned above in the "'Input Type' Variable" section.

3. Analysis of Variance for Accuracy

Table II shows the results of the 4-way analysis of variance for accuracy after performing arc sin transformation on the raw data. The effects each variable had on the result are described below.

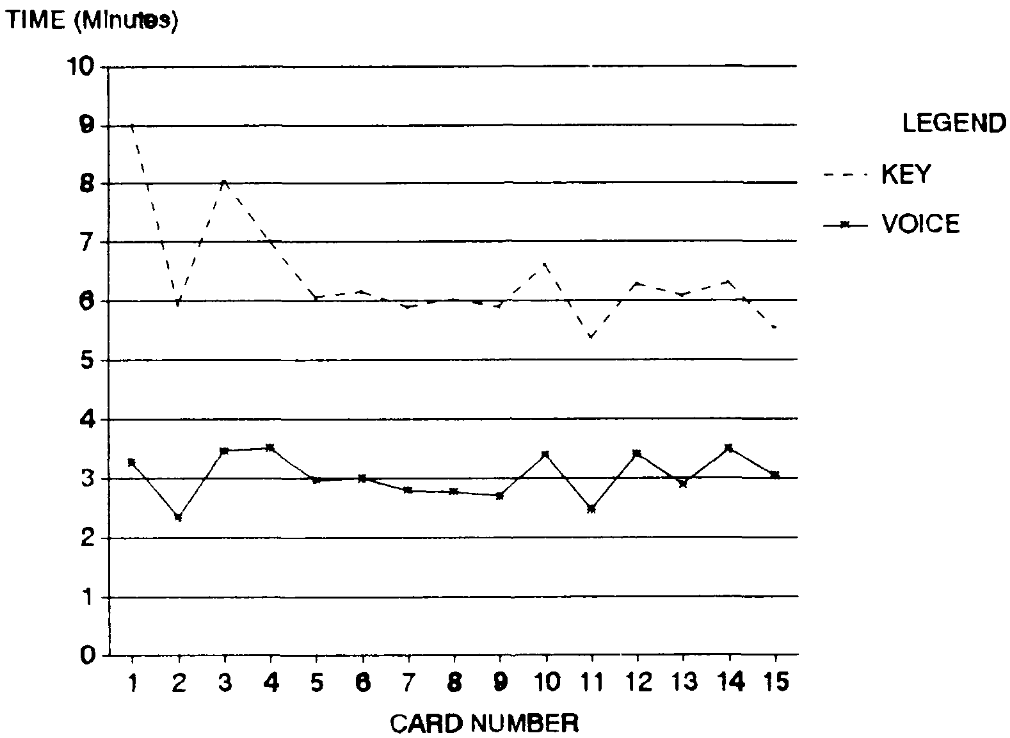

Figure 5 Effect of Input Type and Card Number on Time
- Trial 1 -

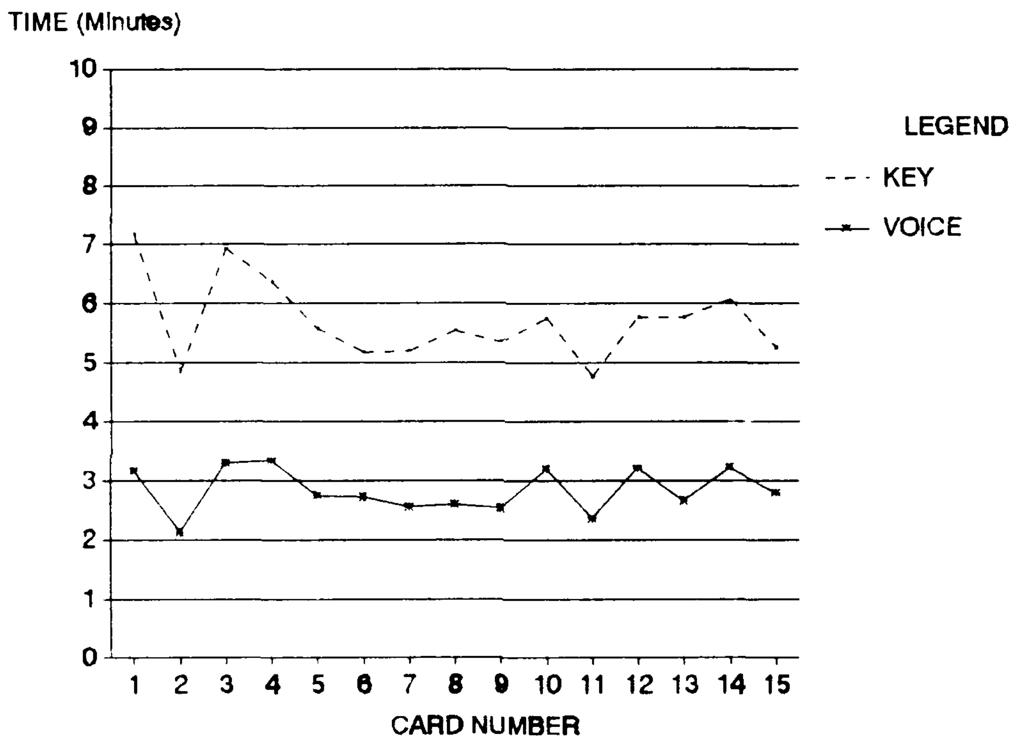

Figure 6 Effect of Input Type and Card Number on Time
- Trial 2 -

TABLE II

ANALYSIS OF VARIANCE ON ACCURACY SUMMARY TABLE

Source	df	SS	MS	F-ratio	Prob
S	9	0.615	0.068	1.407	0.192
C	14	1.312	0.094	1.930	<0.029
TR	1	<0.001	<0.001	0.002	0.965
I	1	0.593	0.593	12.212	<0.001
S,C	126	5.974	0.047	0.977	0.553
S,TR	9	0.404	0.045	0.924	0.506
S,I	9	1.149	0.128	2.629	<0.008
C,TR	14	0.420	0.030	0.618	0.846
C,I	14	0.523	0.037	0.770	0.699
TR,I	1	0.566	0.566	11.658	<0.001
S,C,TR	126	5.623	0.045	0.919	0.681
S,C,I	126	5.455	0.043	0.892	0.739
S,TR,I	9	0.440	0.049	1.007	0.438
C,TR,I	14	0.415	0.030	0.610	0.852
Error	126	6.117	0.049		
Total	599	29.606	0.049		

a. *'Subject' Variable*

As in the time analysis, some subjects performed better on certain cards, trials, and input types, and other subjects vice versa. As stated above, this is an accepted condition.

b. *'Card' Variable*

The variable 'card' had an interactive effect with other variables on accuracy. Once again, this resulted from the fact that no two of the 15 cards had the same content. Some cards required more effort of the subject than others. Thus, 'card' cannot be included as a significant variable.

c. *'Input Type' Variable*

The variable 'input type' had an individual effect on the accuracy results. Figure 7 shows the average accuracy percent correct for all subjects, both for voice and keying. The results are very similar: command entry via keying was, on average, only 2.5% more accurate than command entry via voice.

d. *'Trial' Variable*

'Trial' combined with 'input type' to have an effect on accuracy. Figure 8 depicts the interactive effects between 'trial' and 'input type.' The speech accuracy rate increased and the keying accuracy rate decreased from trial one to trial two. The improved voice results may have been due to subjects' increased familiarity with the speech recognizer. In contrast, subjects' poorer keying accuracy may

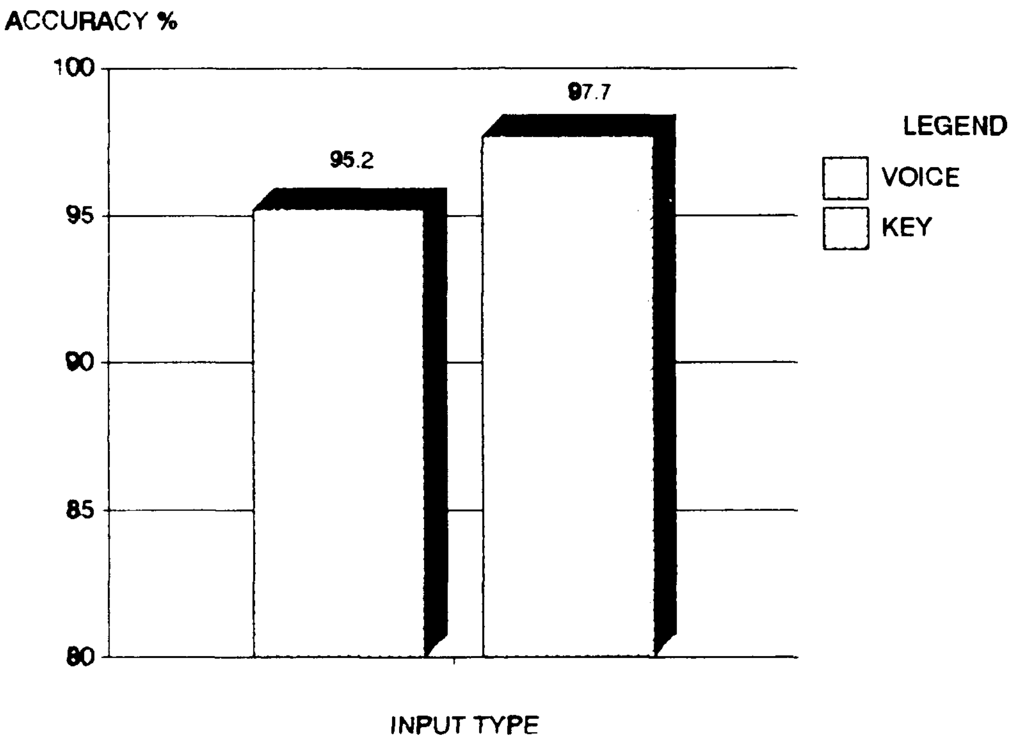

Figure 7 Average Effect of Input Type on Accuracy

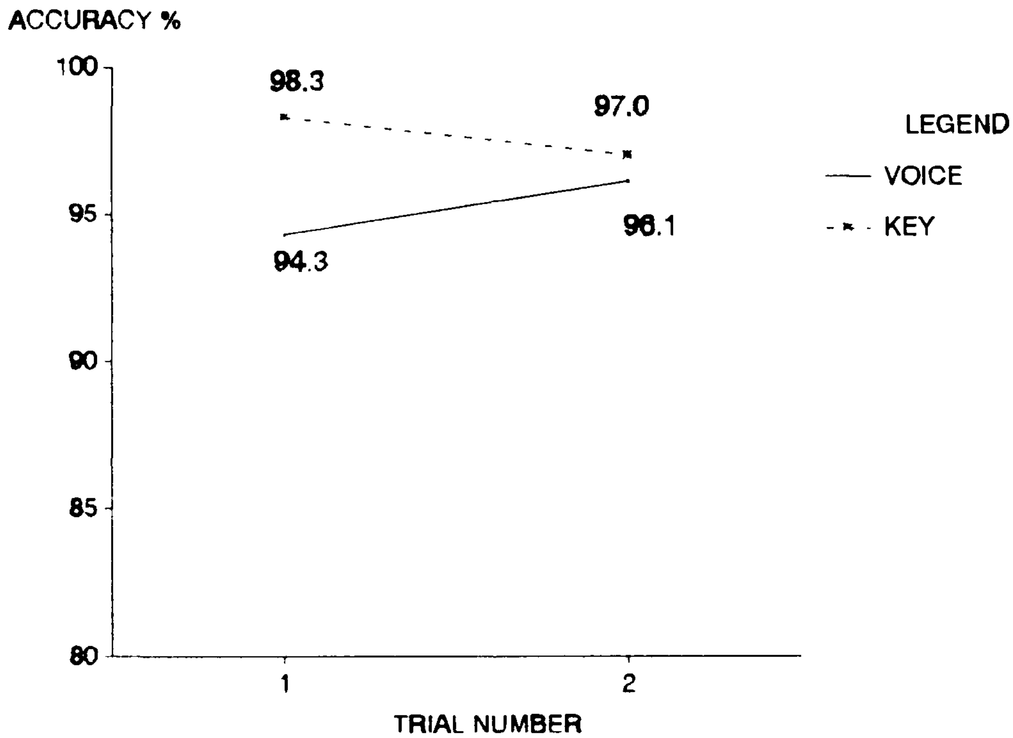

Figure 8 Effect of Input Type and Trial Number on Accuracy

be linked to the decreased keying time for the second trial (refer to Figure 4). As subjects keyed commands quicker, they may have made more mistakes.

B. DISCUSSION

The experiment demonstrated that continuous speech recognition is a quicker means of entering ATO commands than entry via the ATO keyset. In addition, an overall speech recognition accuracy rate of 95% made voice a reliable interface.

1. Safety

Incorporating a speech recognition system in the SH-60B would enable the ATO to be a more effective copilot. He would no longer have to search for keys on the keyset, especially during low light situations, or repetitively shift his attention from the MPD to the keyset. With the use of a speech recognizer, the ATO could eliminate manipulation of the keyset from his taskload. This would allow him to concentrate on scanning the instrument panel and outside the aircraft. By keeping the ATO from looking down at the keyset, he is in a far better position to detect an unsafe flight condition and respond accordingly. Voice input would also free the ATO's right hand to more rapidly take the flight controls from the pilot in an extremis situation.

2. Implementation

In practice, the recognizer would be used in the stand-alone mode. A speech recognizer would be installed in every helicopter, and each ATO would carry his own cartridge containing a recognizer file (common to all users) and a user specific voice file. After manning the helicopter, the ATO would load his cartridge into the recognizer, thereby erasing the previous ATO's files. Enrollment and the first training pass would be conducted in a relatively quiet environment - inside the helicopter when it is shut down. The second and subsequent passes (if needed) would take place in the helicopter during flight.

While using the speech recognizer, the ATO's voice input would have to be blocked from the pilot. Otherwise, the ATO would continually interfere with radio communications into and out of the aircraft. Likewise, while speaking voice commands, the ATO cannot be interfered by, or be involved in, external and internal communications. A remedy would be the installation of a push-to-talk switch, similar to the one now used by the SH-60B crew for internal communications, that would allow the ATO to interface directly with the speech recognizer. For safety reasons, the pilot would be able to use his internal communications override switch (already in place) to "break in" on the ATO's communication with the speech recognizer.

3. Background Noise

Successful operation requires the speech recognizer to differentiate between human speech and background noise. Since helicopters make a considerable amount of noise, the use of speech recognition systems in helicopters has been a challenge. The SH-60B is no exception: an A-weighted spectral noise reading of 103 db was measured in the cockpit of a UH-60A, a helicopter that shares a nearly identical airframe with the SH-60B. (Reed,1992)

Significant success has been achieved in the ability of speech recognizers to perform effectively in helicopters and other high-noise aircraft. For example, flight tests of a speaker dependent, continuous speech recognizer in a JOH-58 scout helicopter were conducted by the U.S. Army Avionics Research and Development Activity (AVRADA) at Ft. Rucker, Alabama. Phrase recognition accuracy of a 54 word vocabulary averaged 90% in a 120+ db noise level environment. Pilots reacted to changes in their environment 23.8% faster when using voice control over cyclic (hand) control. (Holden,1988)

The Naval Air Systems Command (NAVAIR) has recently supported continuous speech recognition flight testing in the Marine Corps' AV-8 Harrier vertical/short takeoff and landing (VSTOL) jet aircraft. Background noise level during speech recognizer training was measured between 105 and 110 db. Flight tests successfully demonstrated speech recognition as an effective means of reducing the pilot's workload and increasing head-out-of-cockpit time. (Holden,1991)

IV. CONCLUSIONS

To summarize, the experiment demonstrated that the manual process of keying commands into the SH-60B's computers is translatable into a set of command phrases that are usable by the Verbex Series 5000 speech recognizer. Results from the experiment show that command entry via continuous speech recognition is a viable alternative to command entry via keying in the SH-60B: voice input was over 100% faster than manual input, with only a 2% deficiency in accuracy. A form of technology that provides the ATO with a quicker means of command entry than currently exists, free use of his hands, and an improved scan, cannot be ignored.

The requirement for the ATO to conduct increasingly complex tactical missions while maintaining a continuous scan of safety of flight parameters can often lead to task overload, primarily at night and during emergencies. As technological advances further expand the ability of speech recognizers to manipulate even larger vocabularies of commands, and improvements continue to be made in noise-canceling devices, the incorporation of a speech recognition system in the SH-60B will be an effective means of reducing the ATO's taskload.

This experiment highlights the need for more research and experimentation to further examine continuous speech recognition as a tactical command entry device in the SH-60B helicopter. This writer recommends that a time and accuracy experiment be conducted using the entire ATO command set (similar to the file listed in Appendix B) once the speech recognition software supports it.

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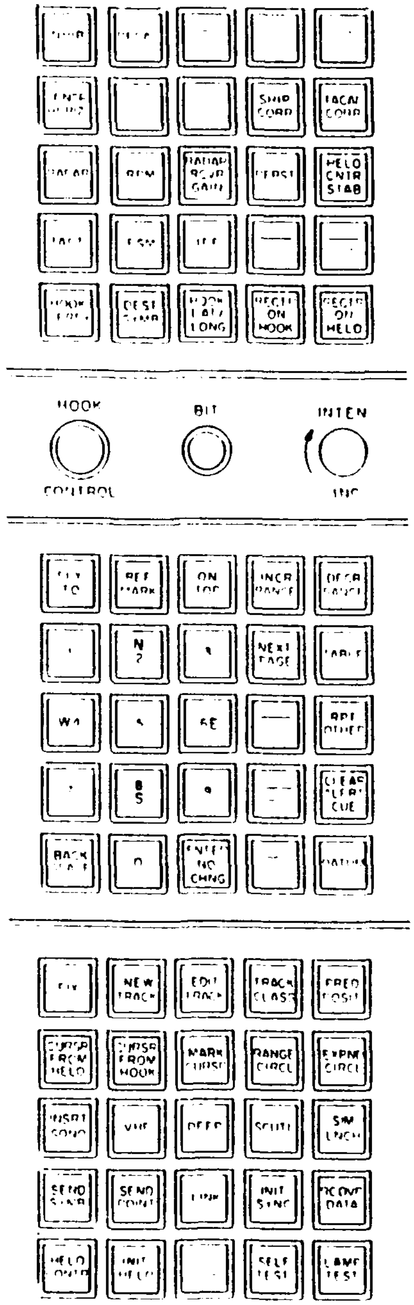
APPENDIX A



ATO KEYSET

APPENDIX B

```
#VOCAB=ATO_COMMANDS
!HOOK1_GRAM=
#RECOGNITION
#GRAMMAR

;HOOK VERIFY
HOOK

;UNHOOK
HOOK

;DISPLAY HOOK LAT/LONG
HOOK SAY LAT_LONG

;CREATE EXPANDING RANGE CIRCLE
HOOK EXPANDING_CIRCLE .DIGIT@1,2

;CURSOR FROM HOOK
HOOK CURSOR_FROM_HOOK

;NEW TRACK (HOOK) 3 PHRASES
HOOK NEW_TRACK
HOOK VISUAL .BINARY
.STATUS .TYPE .DIGIT* ENTER

;NEW TRACK (ASW POSIT) 3 PHRASES
HOOK NEW_TRACK ASW
ASW HOOK
.AR TRACK

;NEW TRACK (ASW POSIT - CUS SPEED) 3 PHRASES
HOOK NEW_TRACK ASW
COURSE_SPEED .DIGIT* ENTER
.AR TRACK

;ATT SONOBUOY ASSIGNMENT/DEASSIGNMENT
HOOK DESTROY

;TRACK CLASS
HOOK CLASS .STATUS .TYPE

;EDIT TRACK (ASW POSIT) 3 PHRASES
HOOK EDIT ASW
HOOK
.AR TRACK
```

```
;EDIT TRACK (REPOSIT) 2 PHRASES
HOOK EDIT
HOOK REPOSIT .DIGIT* ENTER

;EDIT TRACK (TWO POINTS) 2 PHRASES
HOOK TWO_POINTS
.AR TRACK

;EDIT TRACK (HOOK)
HOOK

;PREDICT FUTURE POSITION
HOOK PREDICT .DIGIT@1,2

;MARK CURSOR
HOOK MARK_CURSOR

.DIGIT=
        0
        1
        2
        3
        4
        5
        6
        7
        8
        9

.BINARY=
        YES
        NO

.STATUS=
        FRIENDLY
        UNKNOWN
        HOSTILE

.TYPE=
        BELOW
        SURFACE
        AIR

.AR=
        ACCEPT
        REJECT

#TR

ENTER                   |045
```

```
#NEXT
        MENU_2  >       HOOK2_GRAM
        MENU_3  >       TABLE_GRAM
        MENU_4  >       ON_TOP_GRAM
        MENU_5  >       CREATE_GRAM
        MENU_6  >       RADAR_GRAM


#VOCAB=HOOK2
!HOOK2_GRAM=
#RECOGNITION
#GRAMMAR

;CREATE FIX
HOOK FIX

;SEND SYMBOL
HOOK SEND_SYMBOL

;SEND POINT
HOOK SEND_POINT

;DESTROY SYMBOL
HOOK DESTROY

;INHIBIT SYMBOL
HOOK INHIBIT

;SHIP CORRECT
HOOK SHIP_CORRECT

;FLY TO POINTS (NORMAL) 2 PHRASES
HOOK FLY_TO
NORMAL .DIGIT@1

;FLY TO POINTS (SONOBUOY - CASS DICASS BT) 2 PHRASES
HOOK FLY_TO
SONO .DIGIT@1 .CDB

;FLY TO POINTS (SONOBUOY - LOFAR DIFAR VLAD ANM RO) 3 PHRASES
HOOK FLY_TO
SONO .DIGIT@1 .LDVAR
.DEPTH .LENGTH

;INSERT SONOBUOY 3 PHRASES
HOOK INSERT_BUOY
.BUOY .DIGIT@1,2
.DEPTH .LENGTH
```

```
.CDB=
        CASS
        DICASS
        B_T

.LDVAR=
        LOFAR
        DIFAR
        V_LAD
        A_N_M
        R_O

.DEPTH=
        SHALLOW
        DEEP

.LENGTH=
        SHORT
        MEDIUM
        LONG

.BUOY=
        .CDB
        .LDVAR

#NEXT

        MENU_1  >       HOOK1_GRAM
        MENU_3  >       TABLE_GRAM
        MENU_4  >       ON_TOP_GRAM
        MENU_5  >       CREATE_GRAM
        MENU_6  >       RADAR_GRAM


#VOCAB=TABLE
!TABLE_GRAM=
#RECOGNITION
#GRAMMAR

TABLE PARAMETERS

;HELO POSITION KEEPING (ALTITUDE)
ALTITUDE .ALT .DIGIT* ENTER

;HELO POSITION KEEPING (MAG VAR)
MAG_VAR .DIGIT@2 POINT .DIGIT@1 .EWCOMPASS

·HELO POSITION KEEPING (SHIP CRS/SPD)
SHIP .DIGIT* ENTER
```

```
;HELO POSITION KEEPING (WIND CRS/SPD)
WIND .DIGIT* ENTER

;HELO POSITION KEEPING (BIAS CRS/SPD)
BIAS .DIGIT* ENTER

;HELO POSITION KEEPING (DOPPLER MODE)
DOPPLER .DOP

.ALT=
        RADAR
        BAROMETRIC

.EWCOMPASS=
        EAST
        WEST

.DOP=
        LAND
        SEA

#TR

ENTER           |045

#NEXT

        MENU_1  >       HOOK1_GRAM
        MENU_2  >       HOOK2_GRAM
        MENU_4  >       ON_TOP_GRAM
        MENU_5  >       CREATE_GRAM
        MENU_6  >       RADAR_GRAM


#VOCAB=ON_TOP
!ON_TOP_GRAM=
#RECOGNITION
#GRAMMAR

;ON_TOP SYNCHRONIZATION
ON_TOP .EWCOMPASS .DIGIT@1,2

;POSITION CORRECTION (ON_TOP BIAS) 2 PHRASES
ON_TOP
HOOK BIAS .SRC

;POSITION CORRECTION (ON_TOP BUOY) 2 PHRASES
ON_TOP
HOOK BUOY
```

```
;POSITION CORRECTION (ON_TOP RECOVER HELO)
ON_TOP RECOVER

;TACAN CORRECT (OWNSHIP) 2 PHRASES
TACAN CORRECT OWNSHIP
.AR TRACK

;TACAN CORRECT (REMOTE) 4 PHRASES
TACAN CORRECT REMOTE
.DIGIT .DIGIT* POINT .DIGIT@1 .NSCOMPASS
.DIGIT .DIGIT* POINT .DIGIT@1 .EWCOMPASS
.DIGIT@1,2 .EWCOMPASS

.NSCOMPASS=
        NORTH
        SOUTH

.SRC=
        SAVE
        REJECT
        CORRECT

#NEXT

        MENU_1   >       HOOK1_GRAM
        MENU_2   >       HOOK2_GRAM
        MENU_3   >       TABLE_GRAM
        MENU_5   >       CREATE_GRAM
        MENU_6   >       RADAR_GRAM


#VOCAB=CREATE
!CREATE_GRAM=
#RECOGNITION
#GRAMMAR

;CREATE DATUM
DATUM

;CREATE REFERENCE MARK (HOOK)
REF_MARK HOOK

;CREATE REFERENCE MARK (LAT/LONG) 3 PHRASES
REF_MARK LAT_LONG
.NSCOMPASS .DIGIT@1,2
.EWCOMPASS .DIGIT* POINT .DIGIT@2 POINT .DIGIT@1

;CREATE RANGE CIRCLE
CIRCLE .DIGIT* ENTER
```

```
;CREATE RADAR/MAD SENSOR HORIZON
SENSOR_HORIZON .SENSOR

;CURSOR FROM HELO
CURSOR_FROM_HELO

;RECALL SYMBOL
RECALL

;RADAR DISPLAY
RADAR .RPM

;RECENTER RADAR
RECENTER .RANGE

.SENSOR=
    RADAR
    MAD

.RPM=
     SIX
     TWELVE
     ONE_TWENTY
     STANDBY

.RANGE=
     INCREASE
     DECREASE

#TR

ENTER              |045

#NEXT

        MENU_1  >       HOOK1_GRAM
        MENU_2  >       HOOK2_GRAM
        MENU_3  >       TABLE_GRAM
        MENU_4  >       ON_TOP_GRAM
        MENU_6  >       RADAR_GRAM

#VOCAB=RADAR
!RADAR_GRAM=
#RECOGNITION
#GRAMMAR

;REMOTE SYNCHRONIZATION 4 PHRASES
INIT_SYNCH
.NSCOMPASS .DIGIT* POINT .DIGIT@2
.EWCOMPASS .DIGIT* POINT .DIGIT* POINT
.DIGIT@1 .EWCOMPASS
```

```
;RADAR RECEIVER GAIN
RECEIVER .DIGIT@1

;RADAR PERSISTENCE
PERSISTENCE .DIGIT@1

;HELO CENTER STABILIZE
HELO_STAB

;SONOBUOY INVENTORY MAINTENANCE 3 PHRASES
TABLE_INVENTORY
.DIGIT@1,2 .BUOY
.DIGIT@1,2 .DEPTH .LENGTH

#NEXT

        MENU_1   >        HOOK1_GRAM
        MENU_2   >        HOOK2_GRAM
        MENU_3   >        TABLE_GRAM
        MENU_4   >        ON_TOP_GRAM
        MENU_5   >        CREATE_GRAM
```

APPENDIX C

```
!VOICE_GRAM=
#RECOGNITION
#GRAMMAR

;CREATE EXPANDING RANGE CIRCLE
HOOK EXPANDING_CIRCLE .DIGIT@1,2

;NEW TRACK (HOOK) 3 PHRASES
HOOK NEW_TRACK
HOOK VISUAL .BINARY
.STATUS .TYPE .DIGIT* ENTER

;NEW TRACK (ASW POSIT) 3 PHRASES
HOOK NEW_TRACK ASW
ASW HOOK
.AR TRACK

;NEW TRACK (ASW POSIT - CUS SPEED) 3 PHRASES
HOOK NEW_TRACK ASW
COURSE_SPEED .DIGIT* ENTER
.AR TRACK

;EDIT TRACK (ASW POSIT) 3 PHRASES
HOOK EDIT ASW
HOOK VERIFY
.AR TRACK

;EDIT TRACK (REPOSIT) 2 PHRASES
HOOK EDIT
HOOK REPOSIT .DIGIT* ENTER

;EDIT TRACK (TWO POINTS) 3 PHRASES
HOOK EDIT
HOOK TWO_POINTS
.AR TRACK

;EDIT TRACK (HOOK) 2 PHRASES
HOOK EDIT
HOOK VERIFY

;FLY TO POINTS (NORMAL) 2 PHRASES
HOOK FLY_TO
NORMAL .DIGIT@1
```

```
;FLY TO POINTS (SONOBUOY - CASS, DICASS, BT) 2 PHRASES
FLY_TO
SONO .DIGIT@1 .CDB

;FLY TO POINTS (SONOBUOY - LOFAR, DIFAR, VLAD, ANM, RO) 3
;PHRASES
FLY_TO
SONO .DIGIT@1 .LDVAR
.DEPTH .LENGTH

;INSERT SONOBUOY 3 PHRASES
INSERT_BUOY
.BUOY .DIGIT@1,2
.DEPTH .LENGTH

;SONOBUOY INVENTORY MAINTENANCE 3 PHRASES
TABLE_INVENTORY .DIGIT@1,2
.BUOY .DIGIT@1,2
.DEPTH .LENGTH

.DIGIT=
        0
        1
        2
        3
        4
        5
        6
        7
        8
        9

.BINARY=
        YES
        NO

.STATUS=
        FRIENDLY
        UNKNOWN
        HOSTILE

.TYPE=
        BELOW
        SURFACE
        AIR

.AR=
        ACCEPT
        REJECT
```

```
.CDB=
        CASS
        DICASS
        B_T

.LDVAR=
        LO_FAR
        DI_FAR
        V_LAD
        A_N_M
        R_O

.DEPTH=
        SHALLOW
        DEEP

.LENGTH=
        SHORT
        MEDIUM
        LONG

.BUOY=
        .CDB
        .LDVAR
#TR

ENTER                         1040
```

APPENDIX D

The grammar file is written in Verbex Standard Notation (VSN). VSN allows the user to generalize specific statements that are similar, and notate them in a kind of shorthand. (Grammar Development Manual,1990,p.2-2)

Referring to the grammar file in Appendix B, the first line "#VOCAB=ATO_COMMANDS" defines the vocabulary. "!HOOK1_GRAM=" defines the first grammar section. "#RECOGNITION" and "#GRAMMAR" are mandatory statements that preface every grammar.

The lines that follow define the phrases the recognizer will accept. A line preceded by ";" denotes a comment, which is ignored by the recognizer. In this case, the comment line is used to describe each command and the number of phrases in each command. The recognizer will only "listen for" the phrases defined in the grammar section - and the word order of each phrase must be correct. Therefore, the recognizer will accept the phrase "HOOK" or "HOOK SAY LAT_LONG," but not "LAT_LONG SAY HOOK."

The numbers following ".DIGIT@" define the number of digits that will be accepted in that phrase. For example, both "HOOK EXPANDING_CIRCLE 2" and "HOOK EXPANDING_CIRCLE 22" are acceptable.

In the phrase "HOOK VISUAL .BINARY," the abbreviation ".BINARY" is defined at the end of the grammar section as either "YES" or "NO." The recognizer will accept the phrase "HOOK VISUAL YES" or "HOOK VISUAL NO," but not "HOOK VISUAL."

The "#NEXT" statement at the end of each grammar section allows the user to link multiple grammars. For example, if the phrase "MENU_2" is spoken, the recognizer will only listen for the phrases defined in the second grammar, "HOOK2_GRAM." (Grammar Development Manual,1990,p.2-17)

With a handful of grammar statements, Verbex Standard Notation enables the user to quickly and accurately define everything a speaker says in the performance of his job. (Grammar Development Manual,1990,p.2-2)

APPENDIX E

The 15 Key Cards are listed along the left margin and the corresponding Voice Cards are listed along the right margin. Every card contains 3 commands frequently used by the ATO. Each line of a Key Card defines a single keypress, except where a string of numbers appears. In that case, each digit requires a separate keypress. Each line of a Voice Card defines a single phrase. Therefore, the first command on Key Card 1 requires 15 keypresses, while the same command spoken (the first command on Voice Card 1) requires 3 phrases. Both commands would create a friendly surface track with course 256 degrees and speed 21 knots.

The individual numbers that precede "ENTER NO CHNG" in the key commands represent menu selections. For example, the numbers "1," "2," and "4" select "HOOK," "YES," and "FRIENDLY SURFACE."

KEY CARD 1

HOOK VERIFY
NEW TRACK
1
ENTER NO CHNG
2
ENTER NO CHNG
4
ENTER NO CHNG
256021
ENTER NO CHNG

TABLE
2
ENTER NO CHNG
03
ENTER NO CHNG
8
ENTER NO CHNG
10
ENTER NO CHNG
2
ENTER NO CHNG
1
ENTER NO CHNG

FLY TO
2
ENTER NO CHNG
3
ENTER NO CHNG
7
ENTER NO CHNG

VOICE CARD 1

HOOK NEW TRACK
HOOK VISUAL YES
FRIENDLY SURFACE 256021 ENTER

TABLE INVENTORY 03
BT 10
DEEP SHORT

FLY TO
SONO 3 DICASS

KEY CARD 2

TABLE
2
ENTER NO CHNG
17
ENTER NO CHNG
2
ENTER NO CHNG
08
ENTER NO CHNG
2
ENTER NO CHNG
3
ENTER NO CHNG

FLY TO
2
ENTER NO CHNG
5
ENTER NO CHNG
6
ENTER NO CHNG

HOOK VERIFY
EXPND CIRCL
10
ENTER NO CHNG

VOICE CARD 2

TABLE INVENTORY 17
DIFAR 08
DEEP LONG

FLY TO
SONO 5 CASS

HOOK EXPANDING CIRCLE 10

KEY CARD 3	**VOICE CARD 3**
INSRT SONO	INSERT BUOY
6	DICASS 09
ENTER NO CHNG	DEEP MEDIUM
09	
ENTER NO CHNG	HOOK EDIT
2	HOOK REPOSIT 164014 ENTER
ENTER NO CHNG	
2	HOOK NEW TRACK
ENTER NO CHNG	HOOK VISUAL YES
	FRIENDLY AIR 002367 ENTER

HOOK VERIFY
EDIT TRACK
HOOK VERIFY
2
ENTER NO CHNG
164014
ENTER NO CHNG

HOOK VERIFY
NEW TRACK
1
ENTER NO CHNG
2
ENTER NO CHNG
7
ENTER NO CHNG
002367
ENTER NO CHNG

KEY CARD 4	VOICE CARD 4
FLY TO	FLY TO
2	SONO 4 RO
ENTER NO CHNG	SHALLOW SHORT
4	
ENTER NO CHNG	HOOK NEW TRACK ASW
5	COURSE SPEED 327016 ENTER
ENTER NO CHNG	REJECT TRACK
1	
ENTER NO CHNG	HOOK EDIT ASW
1	HOOK VERIFY
ENTER NO CHNG	ACCEPT TRACK

HOOK VERIFY
NEW TRACK
2
ENTER NO CHNG
2
ENTER NO CHNG
327016
ENTER NO CHNG
2
ENTER NO CHNG

HOOK VERIFY
EDIT TRACK
1
ENTER NO CHNG
HOOK VERIFY
ENTER NO CHNG
1
ENTER NO CHNG

KEY CARD 5

HOOK VERIFY
NEW TRACK
1
ENTER NO CHNG
2
ENTER NO CHNG
5
ENTER NO CHNG
162015
ENTER NO CHNG

INSRT SONO
1
ENTER NO CHNG
13
ENTER NO CHNG
2
ENTER NO CHNG
1
ENTER NO CHNG

HOOK VERIFY
EXPND CIRCL
55
ENTER NO CHNG

VOICE CARD 5

HOOK NEW TRACK
HOOK VISUAL YES
UNKNOWN SURFACE 162015 ENTER

INSERT BUOY
LOFAR 13
DEEP SHORT

HOOK EXPANDING CIRCLE 55

KEY CARD 6

HOOK VERIFY
NEW TRACK
2
ENTER NO CHNG
1
HOOK VERIFY
ENTER NO CHNG
1
ENTER NO CHNG

TABLE
2
ENTER NO CHNG
08
ENTER NO CHNG
5
ENTER NO CHNG
24
ENTER NO CHNG
1
ENTER NO CHNG
3
ENTER NO CHNG

HOOK VERIFY
EDIT TRACK
4
ENTER NO CHNG

VOICE CARD 6

HOOK NEW TRACK ASW
ASW HOOK
ACCEPT TRACK

TABLE INVENTORY 08
RO 24
SHALLOW LONG

HOOK EDIT
HOOK VERIFY

KEY CARD 7

FLY TO
2
ENTER NO CHNG
3
ENTER NO CHNG
4
ENTER NO CHNG
2
ENTER NO CHNG
1
ENTER NO CHNG

TABLE
2
ENTER NO CHNG
01
ENTER NO CHNG
7
ENTER NO CHNG
30
ENTER NO CHNG
1
ENTER NO CHNG
3
ENTER NO CHNG

HOOK VERIFY
EDIT TRACK
4
ENTER NO CHNG

VOICE CARD 7

FLY TO
SONO 3 ANM
DEEP SHORT

TABLE INVENTORY 01
DICASS 30
SHALLOW LONG

HOOK EDIT
HOOK VERIFY

KEY CARD 8

INSRT SONO
8
ENTER NO CHNG
11
ENTER NO CHNG
1
ENTER NO CHNG
3
ENTER NO CHNG

FLY TO
2
ENTER NO CHNG
4
ENTER NO CHNG
8
ENTER NO CHNG

TABLE 2
ENTER NO CHNG
23
ENTER NO CHNG
1
ENTER NO CHNG
12
ENTER NO CHNG
2
ENTER NO CHNG
2
ENTER NO CHNG

VOICE CARD 8

INSERT BUOY
BT 11
SHALLOW LONG

FLY TO
SONO 4 BT

TABLE INVENTORY 23
LOFAR 12
DEEP MEDIUM

KEY CARD 9

HOOK VERIFY
FLY TO
1
ENTER NO CHNG
3
ENTER NO CHNG

HOOK VERIFY
EDIT TRACK
HOOK VERIFY
2
ENTER NO CHNG
351014
ENTER NO CHNG

HOOK VERIFY
NEW TRACK
2
ENTER NO CHNG
1
HOOK VERIFY
ENTER NO CHNG
2
ENTER NO CHNG

VOICE CARD 9

HOOK FLY TO
NORMAL 3

HOOK EDIT
HOOK REPOSIT 351014 ENTER

HOOK NEW TRACK ASW
ASW HOOK
REJECT TRACK

KEY CARD 10

HOOK VERIFY
NEW TRACK
1
ENTER NO CHNG
2
ENTER NO CHNG
1
ENTER NO CHNG
124004
ENTER NO CHNG

FLY TO
2
ENTER NO CHNG
2
ENTER NO CHNG
3
ENTER NO CHNG
1
ENTER NO CHNG
3
ENTER NO CHNG

HOOK VERIFY
EDIT TRACK
HOOK VERIFY
3
ENTER NO CHNG
2
ENTER NO CHNG

VOICE CARD 10

HOOK NEW TRACK
HOOK VISUAL YES
FRIENDLY BELOW 124004 ENTER

FLY TO
SONO 2 VLAD
SHALLOW LONG

HOOK EDIT
HOOK TWO POINTS
REJECT TRACK

KEY CARD 11	**VOICE CARD 11**
FLY TO	FLY TO
2	SONO 2 DIFAR
ENTER NO CHNG	DEEP MEDIUM
2	
ENTER NO CHNG	HOOK EXPANDING CIRCLE 28
2	
ENTER NO CHNG	HOOK EDIT ASW
2	HOOK VERIFY
ENTER NO CHNG	REJECT TRACK
2	
ENTER NO CHNG	
HOOK VERIFY	
EXPND CIRCL	
28	
ENTER NO CHNG	
HOOK VERIFY	
EDIT TRACK	
1	
ENTER NO CHNG	
HOOK VERIFY	
ENTER NO CHNG	
2	
ENTER NO CHNG	

KEY CARD 12

HOOK VERIFY
NEW TRACK
1
ENTER NO CHNG
2
ENTER NO CHNG
2
ENTER NO CHNG
345010
ENTER NO CHNG

HOOK VERIFY
EDIT TRACK
HOOK VERIFY
3
ENTER NO CHNG
1
ENTER NO CHNG

INSRT SONO
2
ENTER NO CHNG
31
ENTER NO CHNG
1
ENTER NO CHNG
2
ENTER NO CHNG

VOICE CARD 12

HOOK NEW TRACK
HOOK VISUAL YES
UNKNOWN BELOW 345010 ENTER

HOOK EDIT
HOOK TWO POINTS
ACCEPT TRACK

INSERT BUOY
DIFAR 31
SHALLOW MEDIUM

KEY CARD 13

TABLE
2
ENTER NO CHNG
12
ENTER NO CHNG
6
ENTER NO CHNG
21
ENTER NO CHNG
1
ENTER NO CHNG
1
ENTER NO CHNG

HOOK VERIFY
NEW TRACK
2
ENTER NO CHNG
1
HOOK VERIFY
ENTER NO CHNG
1
ENTER NO CHNG

FLY TO
2
ENTER NO CHNG
2
ENTER NO CHNG
6
ENTER NO CHNG

VOICE CARD 13

TABLE INVENTORY 12
CASS 21
SHALLOW SHORT

HOOK NEW TRACK ASW
ASW HOOK
ACCEPT TRACK

FLY TO
SONO 2 CASS

KEY CARD 14	**VOICE CARD 14**
INSRT SONO	INSERT BUOY
5	CASS 23
ENTER NO CHNG	SHALLOW SHORT
23	
ENTER NO CHNG	HOOK NEW TRACK ASW
1	COURSE SPEED 142003 ENTER
ENTER NO CHNG	ACCEPT TRACK
1	
ENTER NO CHNG	HOOK EDIT ASW
	HOOK VERIFY
	ACCEPT TRACK
HOOK VERIFY	
NEW TRACK	
2	
ENTER NO CHNG	
2	
ENTER NO CHNG	
142003	
ENTER NO CHNG	
1	
ENTER NO CHNG	
HOOK VERIFY	
EDIT TRACK	
1	
ENTER NO CHNG	
HOOK VERIFY	
ENTER NO CHNG	
1	
ENTER NO CHNG	

KEY CARD 15

HOOK VERIFY
NEW TRACK
1
ENTER NO CHNG
2
ENTER NO CHNG
3
ENTER NO CHNG
087011
ENTER NO CHNG

FLY TO
2
ENTER NO CHNG
1
ENTER NO CHNG
1
ENTER NO CHNG
1
ENTER NO CHNG
1
ENTER NO CHNG

HOOK VERIFY
EDIT TRACK
4
ENTER NO CHNG

VOICE CARD 15

HOOK NEW TRACK
HOOK VISUAL YES
HOSTILE BELOW 087011 ENTER

FLY TO
SONO 1 LOFAR
SHALLOW SHORT

HOOK EDIT
HOOK VERIFY

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