The University of Central Florida
College of Electrical Engineering and Computer Engineering
Dr. Lei Wei
Senior Design 1
Initial Project Document

AUTO FBO

Group 12

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I. Background

The vast majority of airports in the U.S. as well as other parts of the world are non-towered airports. Many towered airports even have non-towered hours of operation, usually during night hours. When active, towered airports are held responsible to maintain safe, orderly, and expeditious flow of air traffic, as well as report accurate and real time weather observations. However, when pilots fly into and out of non-towered airports they are responsible to maintain good communications while operating in the local airspace as well as on the airport's runways and taxiways. Also, the local weather at non-towered airports is not automatically broadcasted over a local frequency and is usually found from other nearby airport's weather report.

One concern pilots face when preparing to fly out of a non-towered airport is how well their radio is working. It is vital for a pilot preparing their aircraft for flight to ensure that their communications systems are properly working. This is especially true for pilots flying under Instrument Flight Rules (IFR), as they must establish contact with air traffic control soon after becoming airborne. With no tower they can only perform a radio check if there are others on the local frequency, which is never guaranteed.

The current local weather is also a concern for both pilots flying into and out of non-towered airports. For pilots flying out of a non-towered airport getting the current local weather is usually done by looking up the weather, observing outside conditions, and collecting nearby airports weather reports. Pilots flying into a non-towered airport, however, do not have the luxury of looking up the current local weather from their plane. The best a pilot flying into a non-towered airport can do is to lookup the weather they will be traversing through beforehand, observe the windsock at the airport, remain conscious of weather conditions around the aircraft, and tune into nearby airport's weather reporting stations. At a towered airport this complication is resolved with an Automatic Terminal Information Service (ATIS) or another equivalent system, which provides highly accurate and current weather as well as other remarks (obstructions near the runways, closed taxiways, other weather information, etc).

In respect to weather, pilots are interested in elements such as the wind speed and direction, barometric pressure, temperature, and dew point surrounding the airport when preparing for a flight, taking off, and landing. Wind speed and direction is of the most concern for pilots, which dictates which runway pilots will take off and land. This is because during the takeoff and landing phase it is desired to have as much wind flowing over the wings of the aircraft to increase both drag and lift. Barometric pressure is used to tune the aircraft's altimeter, which indicates the altitude of the aircraft. Lastly, temperature and dew point are used to judge the density of the air and predict the visibility conditions. The temperature along with elevation gives pilots information on how well their aircraft and if their aircraft is safe to operate in the air. The difference between temperature and dewpoint tells pilots how the visibility is surrounding the airport. This is used decide if an area's airspace is under Visual Flight Rules (VFR) or Instrument Flight Rules (IFR).

II. Objectives

The objective of this project is to build an easy to use, reliable, and efficient way for pilots to receive critical weather information and perform a comm check when flying into a non-towered airport. Our system will provide more information to pilots than a typical windsock thus giving them the data they need to be able to take off and land safely. This system will be comparable to the existing ATIS and ASOS systems in place at larger airports so that pilots will already know what to expect and not have to learn a whole new protocol.

The system will be able to recognize a click signal from the pilot and decide from the signal if the pilot is requesting weather condition information or a comm check. If the pilot is requesting weather information, the system will respond with an ATIS style broadcast with the wind speed, direction, visibility, and pressure. If the pilot is requesting a comm check, the system will respond with a message acknowledging the request and will record and playback the pilot's response so they can hear exactly how their message was received. The system will also respond with a power level to inform the pilot of their signal strength.

A similar system was created for a Senior Design project last year which we will be improving upon. Their audio functionality was poor so we will be reworking the audio chain to improve the quality and signal. This will make the communication check more accurate for the pilot and will make the weather announcement easier to hear and understand. Another improvement will be adding more weather measurements so that the pilot has more complete information for their descent. Instead of just wind speed and direction, we will add additional sensors to read temperature, humidity, dew point, and air pressure. Lastly, we will also add remote access to the webpage to allow the pilot to check current weather conditions visually from anywhere with an internet connection.

III. Specifications

General System Specifications

-- Response Time from Signal Receive: < 3 seconds
-- Final Device Size: < 2 ft. on longest side
-- Measurement Capabilities: Temperature, Humidity, Dew Point, Air Pressure, Wind Speed, Wind Direction

Weather Sensing Specifications

-- Upon receiving the designated cue for a weather report, the device shall return an automated weather message in a precise formatting specific to aviation procedures.
-- Temperature Accuracy: ± 3 C
-- Humidity Accuracy: ± 4%
-- Wind Speed Accuracy: ± 2 kts
-- Wind Direction Accuracy: ± 5 degrees
-- Barometric Pressure: 0.0005 inHg resolution

Communications Check Specifications

-- Upon receiving the designated radio cue for a communications check, the device shall record the pilot's transmission and subsequently transmit the recording back with no added distortion to the pilot for verification.
-- Following the playback of the recording the device shall transmit a message to the pilot detailing the received message's power level.
-- Recording Length: 10 seconds

Project Constraints

-- Cost: Because we have not yet found a sponsor, the cost for parts and development will likely be split evenly between us. Being upwards of $400 means that this will be a very tight and impactful constraint upon our final design and implementation.
-- Time: With a tight schedule for Senior Design 1&2 we will need to maximize the efficiency of the following 26 weeks so that we are able to deliver a final working product.

IV. Design

Hardware Block Diagram

Figure 1; Hardware Block Diagram w/ Assignments

Software Level Layout

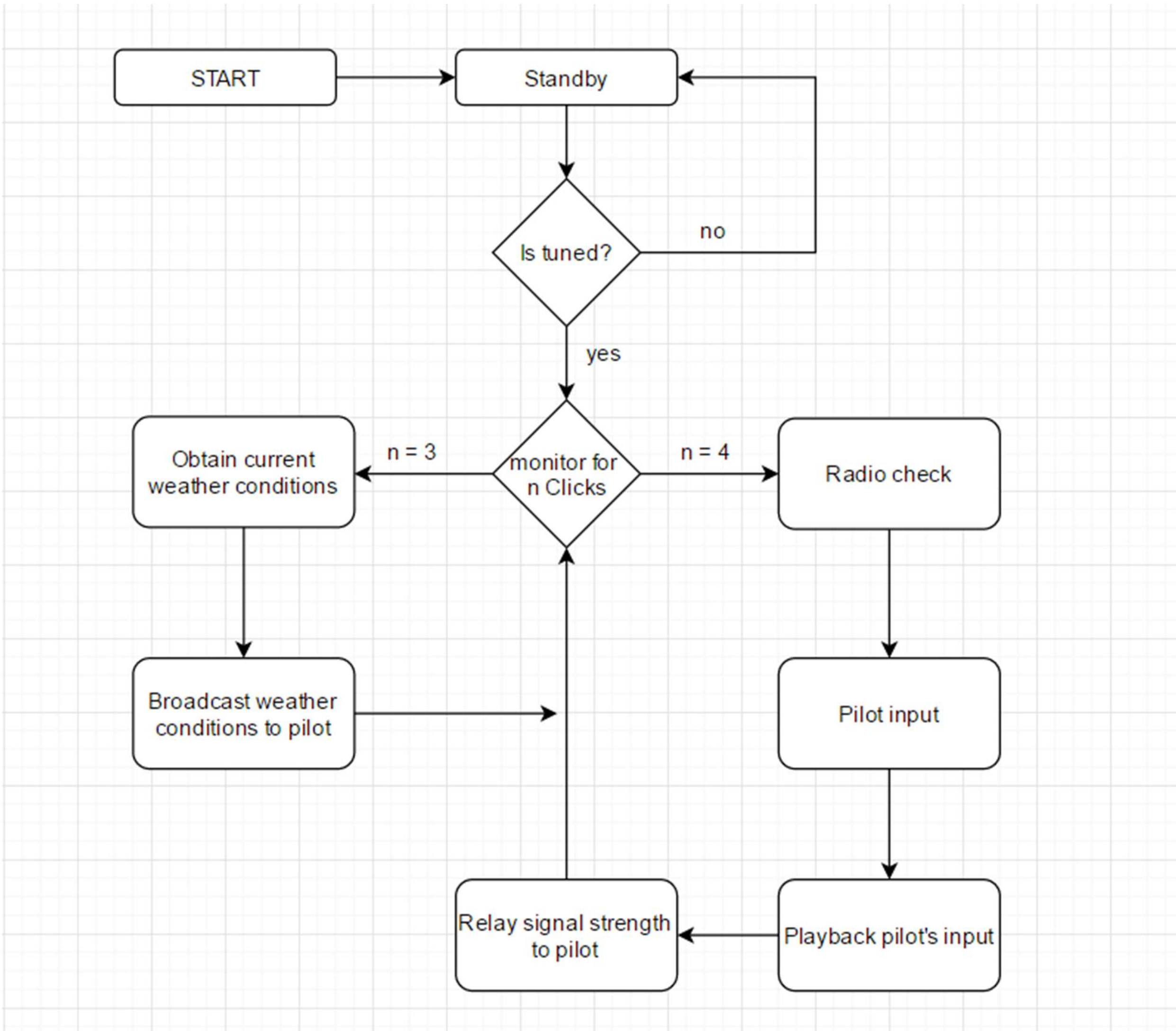

Figure 2; Generalize Software Decision Tree

V. Marketing Trade-Off Matrix

		Implementation Time	Temp. Accuracy	Humidity Accuracy	Wind Speed/Direction Accuracy	Barometric Pressure Accuracy	Dimensions
		-	+	+	+		-
Good Sound Quality	+	↓ ↓	-	-	-	-	↓
Ease of Installation/Setup	+	↑ ↑	-	-	-	-	↑
Low Cost	-	↑ ↑	↓	↓	↓	↓	↓
Quick Responsiveness	+	↓ ↓	-	-	↓	-	-
Multiple Measurements	+	↓ ↓	↑ ↑	↑ ↑	↑ ↑	↑ ↑	↓ ↓
		< 23 weeks	< ± 3 C	< ± 4%	< ± 2 knts. < ± 5 degrees	< 0.0005 inHg	< 2 ft. on longest side

Figure 3; Trade-Off Matrix

↑ ↑ = *Strong Positive Correlation*

↑ = *Positive Correlation*

↓ = *Negative Correlation*

↓ ↓ = *Strong Negative Correlation*

\+ = Positive Polarity

\- = Negative Polarity

VI. Budget

Item	***Design Quantity***	***Backup Quantity***	***Engineering Justification and Notes***	***Estimated Expense***
Anemometer	1	0	Wind speed and direction sensor. Provided by Mr. Young.	$0.00
Barometer	1	0	Atmospheric pressure sensor	$10.00
Hygro Thermometer	1	0	Temperature and humidity sensor	$35.00
Microcontroller	1	3	Receive analog data, convert analog to digital data, process digital data	$30.00
CPU/DSP	1	1	Process pilot voice and commands, provide data to website	$60.00
Operational Amplifiers	6	6	Audio conditioning	$15.00
Comparator	1	3	Carrier detect	$5.00
Diodes	10	10	Audio conditioning	$10.00
Transistors	10	10	Weather instrument signal processing and audio conditioning	$10.00

Linear Regulators	3	6	Convert 13.8 V power supply to lower voltage for different stages	$27.00
Other ICs	N/A	N/A	For possible use system	$10.00
Ports/Headers	N/A	N/A	Supply correct and secure connections	$5.00
PCB + Labor	1	1	Fabricate PCB and install components	$120.00
General Passive Components	N/A	N/A	General resistors, inductors, capacitors for various parts of design. To be provided by TI lab	$0.00
Power Supply	1	1	Provide power for aviation radio and system	$30.00
Aviation Radio	1	0	Used to transmit and receive signals to and from system to pilot	$55.00
Total	-	-	--	$422.00

VII. Milestones

Project Tasks	Design Milestone	Order Milestone	Test Milestone	Final Design Revision and Test Milestone
Weather Instruments	N/A	02/28/2017	03/07/2017	04/18/2017
Weather Instrument Analog System	03/15/2017	03/17/2017	03/27/2017	04/18/2017
Power Supply System	04/01/2017	4/03/2017	04/10/2017	04/18/2017
Audio System	03/15/2017	03/17/2017	3/27/2017	04/18/2017
µC/DSP/CPU	N/A	02/28/2017	03/07/2017	04/18/2017
Webpage		N/A		04/18/2017
Digital Weather Reporting	03/22/2017	N/A	3/30/2017	04/18/2017
Digital Communications Check	03/18/2017	N/A	3/30/2017	04/18/2017
1st Prototype	N/A	N/A	05/03/2017	05/06/2017
1st PCB	05/13/2017	05/14/2017	N/A	05/29/2017
2nd Prototype	06/05/2017	06/06/2017	N/A	06/13/2017
2nd PCB	06/19/2017	06/21/2017	N/A	07/05/2017
60 Page SD1	N/A	N/A	N/A	3/31/2017

Design Draft (15 Pages/Person)				
100 Page SD1 Design Draft (25 Pages/Person)	N/A	N/A	N/A	4/14/2017
Final 120 Page SD1 Design Draft (30 Pages/Person)	N/A	N/A	N/A	4/27/2017