GeneBird

Design & Development of Micro Swarm drones

PREPARED BY

Team - GeneBird

PROJECT TITLE	**Genebird – Design & Development of Micro Swarm drones**		
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DATE OF PROPOSAL	December 27, 2020	**VERSION NO.**	1.0
PROJECTED START DATE	July 2020	**PROJECTED COMPLETION DATE**	June 2021

I. PROJECT OVERVIEW

II. ISSUES

III. TIMELINE / MILESTONES

IV. COST STRUCTURE

V. SCOPE OF WORK

VI. ACCEPTANCE OF PROPOSAL

I. PROJECT OVERVIEW

IDEA BEHIND

What is Genebird?

GeneBird is a project that aims at developing semi-autonomous quadcopters to create agile and autonomous "**Swarm Drones**". With the world stepping into the **4-Industrial Revolution**, GeneBird is equipped to handle the technologies such as **Cloud computing**, **Edge computing**, and **Artificial Intelligence**. With an easy to use and comprehensible interface. GeneBird is aimed at meeting the criteria for new ML-based algorithms. Being a low cost, small and agile flight controller based on **esp8266**, **esp32**, **tiva** and **arduino**. We also will be using these boards onboard Wifi capabilities, we designed an **'ad-hoc' networks** for the swarm formation. Also, to implement different **Machine Learning** or **Computer Vision (CV) Algorithms** from the central controller (Cloud or Edge Computing).

An 'Application' for "GeneBird" will also be developed which will be transmitting the video feed from every single quad to the server for processing. Multiple quads will be controlled at the same time. One of the goals for GeneBird is to **maintain the cost** of individual drones **as low as possible** to **allow scalability**, making each member of the swarm less demanding of resources as well as more efficient in terms of power/energy. GeneBird will be equipped with WiFi connectivity hence, enabling IoT connectivity. From a technological and engineering perspective, UAV's are an excellent way to introduce **STEM (Science Technology Engineering Math)** students to building and maintaining technology.

The implementation of different Machine learning algorithms is more robust in GeneBird; it's easier to implement the different machine learning and computer vision algorithms and can also be used in the study of feedback control systems. By using GeneBird's in colleges and universities one can get a deeper understanding of these subjects. The aim of GeneBird is to push the boundary of what can thus be accomplished with autonomous flight. The use of GeneBird like any other **Un-manned Aerial Vehicles (UAV's)** is in the fields of inspection, surveying, military, cinematography, mapping, and gathering of information from places which are thus considered inaccessible by humans for example a crumbled building in the time of an earthquake or hovering a drone over a drowned village to look for survivors and many more search-rescue operations.

PROBLEM STATEMENT

Why Genebird?

With the population of the world growing so rapidly the use of roads to drive cars has also become hectic. We spend hours in long lines at toll plazas and signal stops often stuck in heavy traffic. Now, imagine there's an operation going on in a hospital and the patient is in severe need of blood or an organ, but due to the non-timely delivery, the patient dies. The vehicles of the courier service companies also crowd the road, and due to heavy traffic more often than we wish it results in a late delivery. Which results in less efficiency and poor productivity of the companies, due to all of the time wasted. The environmental pollution thus created is another hectic.

In times of crisis for example an earthquake, flood, etc. Rescue teams need to face huge calamities in order to perform their search operations which thus, requires the use of more resources as well as putting the lives of the rescuers on the edge as well, with more time needed to search the devastated area's chances are the survivors might die before the rescue team is able to reach to them. In case of fire, the fire brigade may or may not reach in time and has to spend a lot of time in order to locate any civilians if present in the building or not. The inspection of radioactive or hazardous areas also possess an extreme threat to the human life. Security is also a major issue. Patrolling huge infrastructures and responding to any intrusion or anomaly is very cumbersome. Most of all just like everything the advancement in technology has changed the entire means of warfare. The use of guns, shotguns, and helicopters to transport the army squadron from one place to another requires a lot of vigilance and uses up a lot of resources, as well as keeping the lives of all the soldiers at risk.

SOLUTION

To reduce road traffic, methods adopted mainly constituted of car-pooling and promoted more use of public transport rather than the use of a car. We can reduce this ratio by replacing the delivery trucks, package delivery vehicles by a GeneBird based framework, or in other words; a swarm of drones. The use of GeneBird thus will not only increase the efficiency but also the productivity of the company, creating less pollution. GeneBird protects the environment. Drones based on the GeneBird architecture can be used to access areas that are non-accessible by human beings. GeneBird based swarms may be used for search and rescue operations thus, taking less time to find survivors. Swarm drones i-e GeneBird based, may also be used to map the building, inspect the hazardous areas. As soon as a call comes into a fire station not only will fire trucks deploy, drones will deploy from the station as well.

Think of GeneBird as a tool, a tool to help individuals remain safe. Humans are not going to be the first responders anymore, GeneBird based infrastructures are going to be the first responder in crisis management. They can get to the scene much quicker than a fire truck can, they are not in traffic and they don't have to be cautious of the traffic below them. They just go right to the scene and start collecting that critical data. Critical data for example we have topographical software that as soon as the drone gets on the scene of emergency, he can start building a 3-dimensional model of the building that's on fire. Drones can also locate thermal activity within the building, building structure to see if the building is about to collapse. Thus, they can collect a lot of on-scene data before the firefighters even arriving there. So, as soon as the firefighters arrive on the scene, they know exactly what's going on. Able to locate survivors and lost firefighters. GeneBird based infrastructure can be trained on algorithms that will detect a suspicious activity and thus eliminate the target.

GeneBird based technology will be used in surveillance operations i-e autonomous security, monitoring large infrastructures. Reducing or almost eliminating the needs of security guards. GeneBird can be used in developing a framework of drones that may be used for package delivery, a swarm of drones will allow more flexible delivery of packages from one place to another since multiple drones included will increase the load-carrying capacity as well. Most of all it saves all the time that was to be wasted by normal pick-up or delivery trucks. GeneBird; a swarm of drones without doubt dawns a new age of modern warfare. GeneBird may also be utilized in the development and modification of 'Slaughterbots'. Thus, eliminating the target with minimum life risk. Within the firefighting and law enforcement communities' drones are going to bring more security. Furthermore, GeneBird based drones can also be used in pipeline monitoring, geological mapping, topographical mapping, radiation mapping.

GOALS

The goals for GeneBird aim at making the everyday life easy. To reduce the environmental pollution, while providing easy and efficient method for delivering packages from one place to another. Providing a more stimulant and attractive approach applied in STEM education by providing inspiring and captivating practical demonstrations of the different machine learning algorithms, computer vision and different control system's concepts. GeneBird also aims on playing a valuable role in search and rescue operations by reaching the areas that are unreachable by humans. GeneBird also targets itself to be used in national security; as slaughter-bots.

COST & TIMELINE ESTIMATES

We aim to develop this project at the cost of 50,000 PKR. The cost is subdivided into different sections and briefly stated in the cost structure ahead. Basically, the project is divided into three major phases for its development and estimated to be completed before June 2021. In the first phase, we have developed and tested a single drone for on board stability and control using Atmega architecture. This phase is completed successfully on September 2020. In the second phase, we aim to develop ESP8266 based micro drone which would have the capability of in-built OTA Support for offsite software updates. In the final phase, we aim to develop a swarm of ESP 32 based 4 micro drones which would transmit live video onto our edge servers.

II. ISSUES	
ONE	
ISSUE DESCRIPTION	Gyroscope Calibration
LENGTH OF TIME EXISTED	1 week
PREVIOUSLY ADDRESSED?	End of July 2020
WHAT WAS THE OUTCOME?	The accelerometer angle and the calculated gyro angle were different because the accelerometer's base value at horizontal axis wasn't zero. We fixed this issue by adding an offset of base value to calibrate the base angles properly.
IMPACT OF ISSUE	The flight controller failed to stabilize the drone structure and because of the issue, the drone was having a major tilt while flight.
TWO	
ISSUE DESCRIPTION	ESP doesn't have a built-in EEPRROM support
LENGTH OF TIME EXISTED	2 weeks
PREVIOUSLY ADDRESSED?	End of August
WHAT WAS THE OUTCOME?	ESP doesn't have a EEPROM like Atmega, so we divided the flash memory and used a segment of that memory as our EEPROM.
IMPACT OF ISSUE	We were unable to save the I2C line address i.e. Gyro and GPS Address, WIFI SSID and Password and Drone ID.
THREE	
NEED / ISSUE DESCRIPTION	Issues with OTA updates
LENGTH OF TIME EXISTED	1 week
PREVIOUSLY ADDRESSED?	Mid of September
WHAT WAS THE OUTCOME?	Unable to implement remote updates of code directly to flight controller.
IMPACT OF ISSUE	Users had to desolder the ESP from the PCB to update/ change the on-board initial code. While the desolder process ESP and the other on board components could get damaged and the whole flight controller could become useless.
ADDITIONAL INFO	We were able to overcome this issue by separating the Flash EEPROM. We received the OTA files on a separate part of flash memory and afterwards changed the boot address to the new address.

III. TIMELINE / MILESTONES	
OVERVIEW	We have divided the project in overall 3 phases. Every phase has its separate milestones. In the first phase we aimed to develop TIVA and Atmega based drone which would have the capability of self-stabilization and control via RC controller. In the second phase we aim to develop ESP8266 based micro drone designed onto PCB board. The drones would have the OTA support. In between there would be midterm evaluation. In the third and final phase we aim to implement a swarm of 4 micro drones which would transmit live video onto edge server. At the end we would have our final evaluation and report/thesis submission.

MILESTONE	START DATE	END DATE
Development of TIVA and Atmega Architecture based Single drone controlled using RC controller	July 2020	August 2020
Implementation of on-board stability using PID algorithm	August 2020	September 2020
Design of Micro Drone dual layer PCB	September 2020	October 2020
Implementation and testing of OTA support on ESP8266 Architecture	October 2020	November 2020
Title Defense Presentation and Midterm Evaluation	December 2020	January 2021
Testing of ESP8266 micro drone for flight control and stabilization	January 2021	February 2021
Testing and Implementation of Swarm Algorithm on ESP32 based 4 micro drones	March 2021	May 2021
Final Presentation/Evaluation and Report Submission	May 2021	June 2021

IV. COST STRUCTURE			
OVERVIEW	The cost of this project is subdivided into 3 phases. In first phase, we built a single drone which costed around 26,000 PKR. In the second and third phase, we are building 4 micro drones which would cost around 20,000 PKR as a whole. The total estimation of this project is projected to be under the range of 50,000 PKR. Furthermore, the cost is subdivided below for better understanding.		
Phase	**Object Description**	**Qty**	**COST**
Phase 1	Drone Propeller Blade 10" X 4.5" ~ Rs 200	4	800
	Brushless DC Motors 950Kv ~ Rs 1400	4	5600
	Afro ESC 1000 Hz Refresh Rate ~ Rs 800	4	3200
	Flysky TGY-i6 & iA6 6 Channel RC Reciever ~ Rs 9000	1	9000
	Rechargable Lithiom Ion Battery 5200 mAh ~ Rs 4400	1	4400
	Hobbyking Drone Frame 550X ~ Rs 1600	1	1600
	MPU6050 Gyroscope Sensor ~ Rs 275	1	275
	HC-SR04 Sonar Sensor ~ Rs 200	1	200
	ESP 8266 ~ Rs 275	1	275
	Arduino UNO R3	1	750
ESTIMATED TOTAL FOR SINGLE DRONE			26100
Phase 2	Drone Propeller Blade 1.5" ~ Rs 50	4	200
	Coreless Micro DC Motors 3.7mm ~ Rs 250	4	1000
	Rechargable Lithiom Ion Battery 1000 mAh ~ Rs 1250	1	1250
	Dual Layer PCB Frame 5.3" X 5.3" ~ Rs 300	1	300
	MPU6050 Gyroscope Sensor ~ Rs 275	1	275
	ESP 8266 ~ Rs 275	1	275
	Dual Layer Photoresistive Film PCB	1	500
ESTIMATED TOTAL FOR SINGLE DRONE			3800
Phase 3	Drone Propeller Blade 1.5" ~ Rs 50	4	200
	Coreless Micro DC Motors 3.7mm ~ Rs 250	4	1000
	Rechargable Lithiom Ion Battery 1000 mAh ~ Rs 1250	1	1250
	Dual Layer PCB Frame 5.3" X 5.3" ~ Rs 300	1	300
	MPU6050 Gyroscope Sensor ~ Rs 275	1	275
	ESP 32 Camera Module ~ Rs 1250	1	1250
	Dual Layer Photoresistive Film PCB	1	500
ESTIMATED TOTAL FOR SINGLE DRONE			4775
ESTIMATED TOTAL FOR 4 DRONES			19100
SUB TOTAL			45200

V. SCOPE OF WORK	
SCOPE DESCRIPTION	**KEY BENEFITS**
GeneBird aims at contributing to the environment by developing framework of swarm drones that can be used to deliver the packages; removing the delivery vehicles from the roads and thus eliminating the pollution as well. Reducing the amount of the pollution produced by the delivery vehicles by providing an easier to access and efficient method of delivering packages via using a swarm of drones. Thus, also reducing the amount of time it takes a normal delivery vehicle to deliver a package.	**Smart Delivery Services & Pollution Reduction**
GeneBird also aims at providing a more vibrant, stimulant and attractive use in STEM (Science, Technology, Engineering and Mathematics) education by providing a means of aspiring and captivating practical demonstrations of various different mathematical and computational concepts such as the study of different machine learning algorithms such as those used in image recognition and classification, different control system concepts such as feedback closed loops etc.	**STEM Learning & Practical Demonstration of Engineering concepts**
GeneBird also aims at playing an important and valuable role by providing a platform for the development and modification of search drones, able to reach the place of an accident or crisis on time thus monitoring the location and searching for the survivors, producing an AI-based map of the structure thus, guiding the rescuers to the survivors; saving precious time in such critical situations.	**Smart Recue Services & Smart Mapping Services**
GeneBird aims at playing a paramount role in security of stores and infrastructures and thus can be highly resourceful as it's use as Internet of Battlefield Things (IoBT). We also target Genebird to be used in national security. And making a paramount effect in the surveillance and monitoring for large infrastructures.	**Smart Surveillance Services & Smart Warfare Services**

VII. ACCEPTANCE OF PROPOSAL			
AUTHORIZED SUPERVISOR SIGNATURE		**DATE OF ACCEPTANCE**	
AUTHORIZED CO-SUPERVISOR SIGNATURE		**DATE OF ACCEPTANCE**	